Soc. of Mammals

JOURNAL OF MAMMALOGY

AUG 20 1954
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VOL. 35 AUGUST 1954 NO. 3

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Incorporated April 29, 1920

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The Journal of Mammalogy

Journal of Mammalogy is published quarterly by the American Society of Mammalogists, Mt. Royal and Guilford Aves., Baltimore 2, Md.

Persons actively interested in mammalogy may become members of the Society upon nomination, payment of membership dues, and election. Applications for membership may be obtained from the corresponding secretary. The Journal of Mammalogy is sent free to all members of the American Society of Mammalogists not in arrears for dues ($4.00).

Subscription rates are $6.00 per year; single numbers of the Journal are $1.50 each.

Nominations and dues for membership, dues for subscriptions, changes of addresses, orders for back numbers and the two bound indexes, requests for missing numbers, and applications for advertising rates should be addressed to the Corresponding Secretary, George C. Rinker, Department of Anatomy, University of Michigan, Ann Arbor, Michigan.

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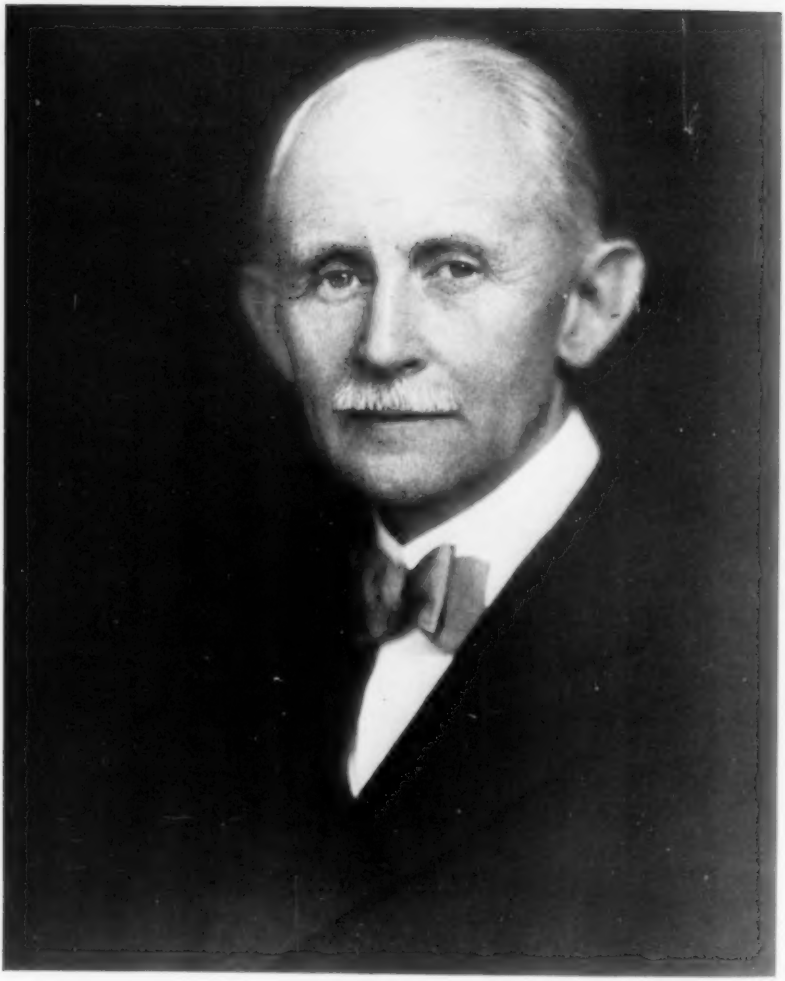
Entered as second class matter, November 22, 1919, at the Postoffice, Baltimore, Md., under the act of March 3, 1879.

Made in United States of America



GERRIT S. MILLER, JR., 1937

JOURNAL OF MAMMALOGY

Published Quarterly by the American Society of Mammalogists

VOL. 35 AUGUST —, 1954 No. 3

GERRIT SMITH MILLER, JR.

In the little village of Peterboro, New York, on December 6, 1869, a son was born to Gerrit Smith Miller and his wife, Susan Dixwell Miller. He was destined to become the outstanding American mammalogist of his generation. He was educated in private schools and by private tutors, and he early developed a great interest in the animal world about him. Instead of spending his time playing with other children, he preferred to wander in the woods in search of animal life. He was sensitive, shy, and seemed to enjoy his own company. This might have been, in part, because he grew up on a large and somewhat isolated estate in central New York.

In addition to his natural interest in living things, he was, no doubt, influenced by a greatuncle, Greene Smith, who lived on the estate. He was a brother to Mr. Miller's grandmother, Mrs. Charles Dudley Miller (Elizabeth Smith). Greene Smith had a large collection of birds, which was stored on the estate in a building erected for that purpose. In 1868–69, he gave Cornell University a very valuable ornithological collection representing most of the species existing in the United States. The specimens were mounted with remarkable skill and care, and their arrangement in the Museum was supervised by Mr. Smith himself. It was known as the Greene collection.

Gerrit S. Miller, Jr., entered Harvard when he was twenty-one years of age, and graduated with an A. B. degree in the class of 1894. In the summer following his graduation an aunt took him to Europe to attend the Wagnerian festival at Beireuth. Shortly after his return from Europe, he joined the Biological Survey, United States Department of Agriculture, under the direction of Dr. C. Hart Merriam. There he continued his study of mammals until 1898, when he came to the United States National Museum as Assistant Curator of Mammals. In 1909 he became Curator, and in 1940 he was retired at the age of seventy. Since 1941 he has been an associate in biology of the Smithsonian Institution.

In 1897 he married Elizabeth Eleanor Page, a woman much older than he with two sons and one daughter nearly his own age. His wife was very ambitious and was greatly interested in his progress and success. No doubt her influence on him was considerable. Mrs. Miller was a very scholarly woman, devoted to the best things that literature has produced. She was reclusive rather than socially inclined, which undoubtedly had a great influence on Mr. Miller and caused him to seek pleasure in his library rather than in social life. The Millers established

themselves in an old frame house on the hilltop north of Hunting Creek, several miles west of Alexandria, Virginia. This house provided an exquisite view of the valley with its extensive marshes and their wonderful fauna. Here hundreds of little blue herons and dozens of American egrets came to feed after the breeding season. It was while exploring these marshes that Miller found the lovely tree frog that he described as *Hyla evittata*.

For several years Mrs. Miller was an invalid, and at the time of her death in 1920 Mr. Miller was physically exhausted from the strain of her long illness. The next summer, accompanied by Dr. Paul Bartsch and J. B. Henderson, Mr. Miller attended the Pan Pacific Congress in Honolulu. When he came back he was greatly improved physically.

After his return to Washington, those who were closely associated with him noticed letters addressed in a feminine hand coming to him rather regularly from Imperial, California. It was learned later that on the sea trip to Hawaii he had met Miss Anne Chapin Gates of New York City, who at that time was a teacher in a high school in Imperial City, California. In the Spring of 1921 he notified his office force that he was disappearing for two weeks—all his mail and other matters were to be held until his return. There was no explanation, but this was not unusual. While he was away a package came from him at Imperial, California, addressed to himself. It was therefore no surprise to have him announce after his return that in June he was going west to be married and would spend most of the summer in Alaska on a honeymoon.

This marriage proved to be a very happy one and produced a complete change of habits. Mr. Miller became a fine dancer and spent many evenings foregathered with groups of friends in various homes in social activities. The second Mrs. Miller made a great change in him. She started out from the first to humanize him, to draw him out of his shell, to make him have a good time and enjoy himself, and to be far less reserved with other people. How well she succeeded can only be understood by those who worked with him both before and after his second marriage.

The Millers purchased a house in northwest Washington on Adams Mill Road, situated on top of a bluff that overlooks Rock Creek and the National Zoological Park. Here their bird-feeding stations never lacked avian guests. At the Zoo, Miller became intensely interested in animal behavior, particularly that of the primates, and spent many hours watching them. These observations furnished much of the material for two later papers: "Some elements of sexual behavior in primates and their possible influence on the beginnings of human social development" (1928), and "The primate basis of human sexual behavior" (1931).

It was on January 2, 1917, that I first met Mr. Miller, having received an appointment to work in the Division of Mammals of the United States National Museum. On arriving for work, I was ushered into Mr. Miller's office; he greeted me pleasantly and asked me to be seated. At that time he was about 47 years of age, though to me he seemed much older as he was already very gray. He had beautiful clear skin and rather pink cheeks. He discussed my duties briefly and

told me the reason he had selected me from several other applicants. After a few more remarks he turned me over to Mr. Arthur J. Poole.

Mr. Miller was then living near Alexandria and was very irregular in arriving at and leaving the Museum. Some days he would remain only a few minutes and hurry away. Other days he would stay until late afternoon. He appeared to be living under a great strain but it never showed in his manner toward people. It was only his apparent haste to get home again. Often he would refuse to see visitors or callers of any kind, particularly if he were about ready to leave.

Miller, as a writer, never had a manuscript completed as long as it remained in his hands. He was constantly writing and rewriting, changing and changing again. He would rewrite an entire page for the sake of changing one or two words to improve his composition or to make his meaning clearer. As a result he had a very clear, beautiful style. His changes were written in very hard lead pencil between the typewritten lines, but even they did not end his work on a manuscript. The next stage could be called the cutting and pasting stage. He would work for months on a manuscript after it was apparently finished, spending hours cutting out here and pasting in there. He would spot a line he wanted to cut out, make an aim at it with his scissors, and when he got the proper sight, cut it off with the speed of a shot.

It was difficult for most people to talk to him. He did not have the faculty of putting people at their ease. His mind did not follow the channels familiar to others and his approach to a subject was often so unexpected that people were so confused they did not know how to answer him. I soon became very much aware of this trait, and it was years before I could talk with him at ease.

Most people in the Museum held him in awe. By some he was greatly respected, by some feared, and by a few who did not understand him, actually disliked. It was difficult for him to unbend. A friend of mine who met him for the first time remarked, "Why, Mr. Miller lives in a little ivory tower all to himself." This was a very apt description. To most people he seemed coldly aloof.

One employee of the Museum once remarked that Gerrit S. Miller, Jr., commanded as much respect about the Museum as the Secretary of the Smithsonian Institution. Others resented the fact that he failed to recognize them in the corridors. It is certain he never intended to create such an atmosphere, but he had an impersonal air about him and was not interested in personalities. It was also evident that Mr. Miller was a very sensitive man, for he would never quarrel with anyone.

One woman whose work required her to visit the Division of Mammals was so afraid of him that she would not come in the office if he were present; she always put her head in the door and asked if Mr. Miller were there before she would enter.

Dr. Leonhard Stejneger was perhaps his closest friend. From 1917 until Dr. Stejneger died their lunches were always taken together, and Dr. Paul Bartsch often joined them. They always went out at one o'clock, Dr. Stejneger coming by to pick Mr. Miller up on his way out. Their conversations were very earnest, and they began talking immediately as they started to walk out of the office.

Often as they went out both seemed to be talking at the same time and one wondered if each was trying to make his point without hearing what the other was saying. They seemed to enjoy each other thoroughly.

Mrs. Oliver Wendell Holmes, wife of the Chief Justice, was Mr. Miller's aunt, a sister of his mother. It was generally understood that Mr. Miller was her favorite nephew. She often visited him at his office in the museum. She was a little white-haired lady in her seventies, always dressed in black, who slipped quietly in and out of the office. She took no notice of those in the outer office as she passed through. If Mr. Miller were in, they would visit; if not, she would leave without inquiring about him. She always came in a horse-drawn vehicle attended by her footman. When Mr. Miller was ill in the hospital after an operation, she brought him a very small pasteboard box, which, she told him, was "good for that tired feeling." When he opened it, he found a small rocking chair.

Much of Mr. Miller's young manhood was spent in Boston. He has told how he attended all the operas, and it was there that he must have acquired his knowledge of music. He had a deep cultural appreciation of music and also of art. He had no interest in sports.

A caller at the museum once said that Miller knew more about music than many college professors who were teaching it. Mr. Miller once remarked that he cared nothing for the human voice. He knew music and could look over a composition intelligently, but music did not seem to mean much to him in an emotional way. His taste in music and art was coldly intellectual, and he often liked what seemed strange or unusual to others. As for flowers, while most people admired the large zinnias, he preferred the small, single-leaved ones. His office associates sometimes laughed about Mr. Miller's fondness for some of his prints; it seemed that the worse they looked and the more scratched they were, the more he admired them.

The writer shall always consider it one of the great privileges of his life that fate placed his path beside that of Mr. Miller and that he had the pleasure of associating with such a man. Underneath his cold exterior there was a very warm gentle nature.

To understand Mr. Miller, the man, it is necessary to give some of his family background, which is most unusual and very interesting. Peter Smith, Mr. Miller's great, great grandfather, was born at Greenbush, Rockland County, New York, November 15, 1768, the descendant of Hollanders who were among the earliest to settle in America. When Peter was sixteen years old, he became a clerk for an importing merchant in New York City, and finally formed a partnership with John Jacob Astor, a poor youth like himself. The two kept a small store and traded furs at first hand with the Indians. Smith ultimately made his residence in the Valley of the Mohawk, at Utica, and the furs were sent to Mr. Astor in New York. In the course of time the partnership was dissolved, and while Mr. Astor bought real estate in New York City, Mr. Smith purchased 60,000 acres of land in central New York State, at $3.53 per acre. Enough of this was sold at auction in 1802 to repay the purchase price, and Mr. Smith was still the largest landholder in the state. Subsequent additions made him the owner of more acres

than any other one man in the country. At one time he owned between 500,000 and 1,000,000 acres of land. In 1792, he married Elizabeth Livingston, who died in 1818.

At the time Peter Smith came into possession of what later became Peterboro, it was a magnificent hilltop, the abode of an Indian tribe. On this hilltop in 1806 he erected the family mansion, which was occupied by some member of the family until it burned to the ground in 1936. When Gerrit Smith Miller, Sr., died on March 10, 1937, the estate was sold and passed out of the hands of the family.

Peter Smith became the first judge of Madison County and established the first newspaper in the county. He died on April 3, 1837, at Schenectady and was buried in Peterboro, the beautiful little hamlet that he founded and that he dreamed might be a metropolis.

His second son, Gerrit Smith, philanthropist, abolitionist, and reformer, was born at Utica on March 6, 1797. He had planned to study law, but after college his mother died, and he came home to take charge of the estate. He was married first to Wealtha Ann Bachus, who died a few months after their marriage in 1819, and then to Ann Carroll Fitzhugh, who bore him four children, two of whom lived to maturity. One was a daughter, Elizabeth, and one was a son, Greene. His second wife brought five slaves to Peterboro; they were freed, but they and their descendants remained on the estate until it was sold in 1937.

Gerrit Smith gave vast sums of money to colleges and individuals. He founded a Negro colony, giving each person forty or sixty acres of land. It proved a failure. He spoke before the state legislature and also before Congress. He gave away $8,000,000 in all and left an estate of over $1,000,000. His daughter Elizabeth married Charles Dudley Miller, a young banker in the town of Cazenovia, and to this union was born a son, Gerrit Smith Miller, who later married Susan Dixwell. These were the parents of Gerrit Smith Miller, Jr.

Gerrit Miller, Sr., after his parents' death, became the owner of the estate. He introduced into this country one of the first registered herds of Holstein cattle and at the time of his death he still owned some of their descendants. He attended the Dixwell boys school in Boston in 1865–66 but left because of poor health. He was a Unitarian. He founded the Oneida Football Club of Boston in 1862; a tablet to the team was unveiled on Boston Commons in 1923. The name Oneida was taken from a stream that flowed through the Peterboro estate. Gerrit S. Miller, Sr., is generally conceded to have devised American football.

His wife, Susan Dixwell, was the great granddaughter of the regicide Dixwell, who fled England because of the part he played in the conviction and death of Charles I. He was buried in New Haven, Connecticut. Gerrit Miller, Sr., and his wife lived at first in a cottage on the estate until his parents died, when they moved into the big house. She was a brilliant girl, accustomed to the culture and life of Boston, and found it difficult to live such a lonely life as was necessary on this large estate. Her son Gerrit, Jr., is said to look much like her and to have inherited much of his brilliant mind from her.

Mr. Miller's first interest in zoology was centered on birds, as was true of a good

many students of zoology at that time, no doubt because birds were so much easier to see and to collect than most other animals. The traps and the techniques for collecting mammals were not so well developed then as they were later under Dr. C. Hart Merriam. Gerrit Miller's first paper was ornithological, "Description of an apparently new Poocætes from Oregon" published in 1888 when he was 19 years old. His first mammal paper was "Description of a new jumping mouse from Nova Scotia and New Brunswick" (1891). In all, he published 400 papers, mostly on mammals, but some on birds, reptiles, amphibians, and plants, with a number of reviews and several important translations of works on mammals.

Perhaps his three outstanding publications were "The families and genera of bats" (1907), "Catalogue of the mammals of western Europe" (1912), and the series of checklists of North American mammals (1901, 1912, and 1924).

"The families and genera of bats" was the most comprehensive work that was ever attempted on the subject. It was only made possible by the very large collection of bats, especially those preserved in alcohol, in the U. S. National Museum collection. The importance and value of this bulletin can be estimated only by the mammalogists who have since made use of it.

His "Catalogue of the mammals of western Europe" was no doubt Miller's greatest contribution. It was a fine piece of work, so thorough that even today it still holds first place as the authority on the mammals of western Europe. At the time it was written the British Museum had the largest collection of European land mammals extant, numbering about 5000 specimens. The U. S. National Museum had about 4000 specimens, and without the help of the latter collection a monographic study of these animals could not have been made. The work was based on a total of 11,500 specimens. This collection had been augmented by Mr. Miller himself with other trained collectors filling in the gaps. For some time Mr. Miller had been working independently on the subject. In 1905 he arranged to devote his entire time for a considerable period to the study. In 1908 he was granted a furlough of two and one-half years from his duties at the National Museum in Washington. Most of this time was spent in Europe working on his manuscript and also doing some collecting. This work established him in a position of high rank among mammalogists, and from then on he increased in stature to become the leading mammalogist of his age in America.

How valuable his checklists of North American mammals are is well known to the hundreds of mammalogists who have worked with them. From the time of the publication of the 1912 list he kept a very careful and exact card index of all the new forms as they appeared in print.

In August, 1899, he published the first bulletin on "Directions for preparing study specimens of small mammals," which went through six editions. These directions were written primarily for young mammalogists who did not know the art of making up study skins, and also to be used to answer the many questions coming to the Museum concerning such work.

A translation of unusual worth was that of "A review of the interrelationships of the Cetacea", by Herluf Winge, from Danish into English (1921). This was

done at the request of the Smithsonian Institution. How well he did it is shown by a letter from Winge which said, "I beg you to accept my sincerest thanks for your translation of my Cetacea, and I congratulate you on the good completion of a difficult task."

Mr. Miller did not confine himself to any one phase of mammalogy, but as he grew older he did less taxonomic work and devoted himself to many other questions about mammals. His paper "The controversy over human missing links," (1928) is a fine example of his lucid writing.

His greatest work was done in the laboratory rather than in the field, but he was a tireless collector even in groups other than mammals. He knew the technique of preparing specimens and made up beautiful skins. He concerned himself with the arrangement and development of the large collection of mammals under his charge in the National Museum and made it one of the very best. In the early twenties he became interested in the kitchen middens of Haiti and the Dominican Republic. He made two different collecting trips, the first to Haiti and the second to the Dominican Republic for a study of the remains of rodents and other mammals found in the caves. A collector was kept busy in these places through Mr. Miller's influence in subsequent years. Mrs. Miller accompanied him on these trips, and it was after the last trip to the Dominican Republic that both returned in bad health.

Mr. Miller often remarked that when we knew everything about mammals the work on mammalogy would be done.

The writer was working with him when the controversy over the so-called Piltdown man was at its height. There is no doubt that if Mr. Miller, with his keen mind and powers of observation had been able to examine the original specimens he would have discovered what has been discovered nearly forty years later, that the jaw was not fossil. In his first paper on the Piltdown skull he said: ". . . on the basis of the evidence furnished by the Piltdown fossils and by the characters of all the men, apes and monkeys now known, a single individual cannot be supposed to have carried this jaw and skull." Time has vindicated his stand and shown him to be right.

Mr. Miller had the true scientific mind. He was not only a distinguished mammalogist; he also enriched his life by a life-long study of music and, in later years, of modern art. He never speculated, but in all matters that he entered into he had the scientific approach. He cared nothing for publicity. His work was done to satisfy his own mind's curiosity and for the pleasure he derived from the search. He had no time for people unless he felt that they had something worth offering, nor for mere sociability. He would listen carefully to an argument, and if the reasoning were right he agreed. He never had a desire to interfere with what others wanted to do, but he could be very brusque if he was hurried or did not wish to be annoyed.

As a mammalogist, this age has not produced another like him. There may never be another with the background he had. Those who were associated with him realize this more than others. His dignity was such that he received a respect that few men ever attain. He is an aristocrat both as to heredity and as to the

height of attainment in his profession. He has the background that wealth and prominence of family can give, and the culture and education that only money can supply. The deference and respect that was shown him by men of prominence who visited the Museum was evident to all.

In spite of all the influences around him he lived his life in a world of his own. He was interested only in the things that he loved and was seldom annoyed by those about him.

In recent years he has taken no active part in the study of mammals. His life is spent quietly in his home with Mrs. Miller, with a yearly summer trip. In a recent talk with him he said that he had found life to be a pretty nice adventure. —H. HAROLD SHAMEL, *Cherryvale, Kansas.*

I would like to enlarge briefly on one side of Gerrit Miller's character that may not generally be known. From his childhood on, he has had a life-long serious interest in music. As a child he studied harmony and composition, and throughout his life he has devoted much time to the study of, and attendance at, the great operas and orchestral performances in Washington, New York, and Boston.

From Gerrit Miller's carefully chosen examples of modern music and art, many concerts and art lectures have been given, illustrated from the large personal collection that crowds his library shelves and studio walls at home. This facet of his mind throws a strong light upon the brilliancy of Mr. Miller's individuality.

After Mr. Miller's appointment as Curator of Mammals, he made many collecting trips to the West Indies and Panama. Because of my previous training in official Girl Scout Camping, Mr. Miller turned over to me all of the details of these collecting trips that were concerned with personal health and comfort. No illness resulted from the many changes of diet and living conditions encountered in the islands of Barbadoes, St. George, Puerto Rico, Jamaica, Santo Domingo, Haiti, and in Panama. These trips were taken during the winter months of a number of years.

One objective of some of these trips that enlisted Mr. Miller's special attention and effort was to find, if possible, the bones of *Solenodon*, the animal described by Oviedo, the Spanish historian of Columbus' voyages, as the one brought as food by the natives to the Chiefs of the Caribs who had retreated into the caves before the Spanish invaders. Therefore we visited the caves of Santo Domingo to seek the bones of that animal.

Samona Bay on the eastern end of the island is formed by a drowned river mouth. Its southern shore consists of high cliffs in which surface waters have worn out many caves. The pounding waters of the bay had made many orifices by which the caves could be entered by visitors in boats from the north shore. Sailing across the bay with food and camping equipment, we spent many weeks in these wet caves associating with bats, rats, and owls.

The central depression in each cave floor was obviously the fireseat, and the mound encircling the depression must have been formed by the bones of the

birds, fish, and other animals that constituted the food of the natives. Digging (with the aid of three dark-skinned owners of the boat) in the cave known as El Diabolo, far back in the floor, Mr. Miller found the long-sought bones of the solenodon, thus affirming its earlier existence in the islands.—ANNE G. MILLER (Mrs. Gerrit S. Miller, Jr.)

In 1909 and 1910 I was working at the British Museum in London, and it was then that I first met Miller. It was the time when Oldfield Thomas was at the height of his activity, and when he had built up the world-wide contacts that enabled him to bring together the unparalleled collection of mammals upon which we still all depend. It was on this collection, admirably kept in shape by W. Shervin, that his own vast contribution to mammalogy was based, and it was this collection that was of such influence in training others, because its identifications were kept up to date by Thomas himself, and his staff. Among the mammalogists working in the mammal room at that time were Knud Anderson, who was preparing the second volume of the "Catalogue of Chiroptera" (which disappeared with him); R. Lydekker; and R. C. Wroughton, well known for his work on African and Indian mammals and the originator of the mammal survey of India. There were many less regular but nevertheless important visitors to the mammal room, Barrett-Hamilton, Hinton, Pocock (who was then at the Zoo), H. C. Robinson from Malaya and foreign guests, D. G. Elliot (then preparing his "Review of the Primates"), E. Heller (just back from East Africa with Theodore Roosevelt), Osgood from Chicago, and Miller.

This was not Miller's first visit to Europe. For years he had been building up a collection of European mammals in Washington with the help of Dane Coolidge, Thora Stejneger, and O. Boettcher, and he had been himself over a good part of Western Europe, Spain, the French Pyrenees, Switzerland, northern Italy, and England. He had also been studying the material in many European collections and had established contacts with many of the European mammalogists, such as Trouessart in Paris, Matschie in Berlin, and Cabrera in Madrid. His influence on European mammalogy was considerable already, not least because he introduced the American method of making skins, setting lines of traps, and especially of assembling long series of specimens to show the extent of variation. He greatly impressed Thomas on his first visit to London with a collection of small mammals which he had made in the New Forest in Hampshire.

Thomas was greatly interested in European mammals and there was a good collection at the British Museum from many parts of Western Europe, especially England. Thomas himself had collected in France and Portugal, and the interest and funds of Lord Lilford had contributed a lot of material so far unworked. Miller had made comprehensive studies of the mammal fauna of Western Europe, introduced the subspecific concept into European mammalogy, and discovered the existence, in unexpected localities, of glacial relicts like the Alpine shrew (*Sorex alpinus*) in the Harz mountains of Germany and the pigmy Asiatic shrew (*Crocidura suaveolens*) (then called *mimula*) as recent members of the West

European fauna. Thomas, therefore, induced him to write a comprehensive catalogue of the Mammals of Western Europe for the British Museum and obtained his services from the Smithsonian Institution for this purpose. That this "Catalogue" was an unqualified success there is no doubt. Some of its taxonomic conclusions have been improved upon with more and modern material, but this work has put our knowledge of European mammals on a new and safe footing, and with its good descriptions, locality records, and measurements, is still the indispensable handbook used by every European mammalogist. Miller's European collections were bought by the British Museum, as was also his private collection of North American mammals. Another North American collection was later obtained by Hinton through exchange with the Chicago museum. Although not adequate by any means, these two collections are now the only sizeable representations of North American mammals in European museums.

As far as I know, Miller never returned to Europe after 1910. In spite of the relatively short time that he spent in the Old World, his influence on European zoology was profound. The "Catalogue" and the methods that he brought from America have made him the father of modern European mammalogy.—Ernst Schwarz, *Bethesda, Md.*

On a sunny summer day just sixty years ago while strolling along the bank of the Charles River in West Newton, Massachusetts, I met a young man whose curiosity had been aroused by my insect net. He introduced himself as Gerrit Miller. I had heard quite a bit about him from Charles J. Maynard, whose establishment nearby was a sort of informal meeting place for all young naturalists for many miles around. Both Miller and I were frequent visitors to Mr. Maynard's shop, although we had never met there.

It was not until I came to Washington that I saw Miller again. Here I found him in a pleasant and cozy office in the eastern end of the Arts and Industries Building, busily engaged in the intensive study of mammals. But mammals were by no means his only interest. Of a shy and retiring nature, recreation for him consisted in attempts to satisfy an absorbing curiosity in many diverse lines. He had an unusually detailed knowledge of botany, and was exceptionally well grounded in philosophy, art, music, and languages, particularly French.

Like many other cultured and learned gentlemen he avoided the oratorical rough and tumble characteristic of most of the scientific meetings of fifty years ago, though he took keen delight in quiet discussions of almost any scientific or cultural subject. His great fund of information, his extraordinary powers of analysis and uncanny ability to separate the essentials from the penumbra of non-essentials in a mass of data, and his devastating logic made him a most stimulating companion.

But few of Miller's scientific colleagues had such a broad cultural background as he, or such diversified interests. So he was forced to find his most congenial companionship mainly outside the circle of his usual associates. Probably his most sympathetic companion was Justice Oliver Wendell Holmes, who had

married his mother's sister. Justice Holmes used to complain that most of his colleagues were interested only in the law, especially in its application, and he welcomed discussion of human interrelationships based upon premises other than the history, development, and application of the law. Miller's interpretation of human interrelationships based upon purely zoological data and analyzed philosophically appealed strongly to Justice Holmes. He was particularly impressed by the fact that conclusions reached through a comparative study of the law and by the study of man as a social animal were extraordinarily similar in spite of the completely different approach.

Justice Holmes, who never read newspapers, liked to keep in touch with current thought, which he tried to do through companionship with young men, chiefly young lawyers in the Government service. But here he encountered a difficulty. Most of these young men stood in awe of him and were afraid to speak out frankly in his presence. This worried him considerably. He could not see why anyone should be diffident about expressing themselves just because he might possibly not agree with their viewpoint. Miller, afraid of nobody and with complete self assurance, was just the type of young man most congenial to him. They discussed all sorts of subjects. Justice Holmes was particularly impressed with Miller's paper on the jaw of the Piltdown man, and with his scepticism regarding the existence of those hypothetical creatures popularly known as "missing links." But on the subject of modern art Miller and the Justice were far apart. Miller maintained that modernistic artists were trying to do something new—that to repeat what had been done was a bore. Justice Holmes told him he thought it better to keep to the old paths unless one really had something new to say.

It must not be assumed that Miller did not find any congenial associates in scientific circles. Very few scientific men in Washington had as many enthusiastic admirers as he. This is well known to everyone. What is not so widely known is that he was an important factor in arousing interest and confidence in scientific work in circles far beyond the usual orbit of a research student.—Austin H. Clark, *Washington, D. C.*

I have known Miller since the last part of the last century. We lunched together for many years. He is a scholarly man, always the gentleman in the fullest meaning of that word, whose achievements in mammalogy are well known by his associates.

There was one phase of his activities that is probably not known by many, namely, Futurism. I recall spending a Sunday afternoon with him while Mrs. Miller was up north, when he brought out a huge portfolio of drawings and spread them about the room. Futuristic endeavors prior to this had always appealed to me as the product of an unsound mind. I recall his asking me what I thought one of the pictures represented. After looking at it a while I felt depressed and said "Calamity." I made several more fortuitous guesses which led me to have a more generous designation for futurists than I had entertained before.

In more than half a century I have never known Miller to do or say a mean thing. Scientists by nature are a critical group and more or less selfish. Miller, whether acting as Head Curator of the United States National Museum or Curator of the Division of Mammals, was always honest, fearless, fair, and unselfish.—Dr. Paul Bartsch, *Lorton, Va.*

The development of Gerrit Smith Miller, Jr. as a mammalogist was not unlike that of many of us, but in his critical, unswerving, and philosophical analysis of problems he was unlike anyone else. Many of us believe him to be the greatest mammalogist of all time. He gave that glory to Oldfield Thomas, and modestly placed others above himself.

Miller has been misjudged by many people who consider him somewhat of a recluse and hard to approach. It is a part of his innate psychology to avoid strangers and strange crowds. Once, after persuasion, he endeavored to give a talk before the Biological Society of Washington and was so overcome that he was helped from the floor without delivering his address. He was too wise ever to try it again.

When I first met him in his office in February, 1910, he was unresponsive, and I felt somewhat out-of-place. I soon learned to understand the man, and in the 44 years since have never received anything but a welcome, and help when requested. True, he is sometimes abrupt, a man of few words, but I have never in this time heard him speak a harsh or unkind word. He has interests little known to many. He has been a keen critic of music and art. He played musical instruments, and used to urge me to continue my violin playing after I laid it aside for zoological research, saying he would come to my home for rehearsals with me. We frequently talked about various symphonies, he always demanding the most technical and unusual, although he respected my recommendations on concerts. He was active in publishing important botanical papers until 1912, and continued to have an interest in plants. Miller is greatly misunderstood by some, but, to those who know him, he is the prince of fellows.—Dr. Hartley H. T. Jackson, *Washington, D. C.*

Gerrit S. Miller, Jr. is a gentleman of the first magnitude. His write-up in American Men of Science is one of the shortest for a scholar of the finest quality, and an indication of his modesty. He never sought high offices and was content to work at his chosen field. Until about 1935 Mrs. Wright and I knew Mr. and Mrs. Miller quite well, and we never can forget the delightful winter visit we had with them at Peterboro, N. Y., where we saw the old home that was to have been made a state monument. Alas it burned! Right there in Peterboro swamp and its vicinity Gerrit pioneered in North American mammalogy.—Albert Hazen Wright, *Cornell University, Ithaca, N. Y.*

During the five years of the mid-twenties that I was working on the mammal collections in the U. S. National Museum I was in daily contact with Mr. Miller. I fully appreciated the privilege of this association with the greatest taxonomic mammalogist that we have ever had. To me, Mr. Miller's outstanding attribute

was his remarkable knowledge of the details of the mammals of the world and of the literature of the subject. It still seems to me as though there was no form of mammal of which he did not know the characters and just what had been published about it and where. My enthusiasms must often have been a trial to him, but I fail to remember a single instance of impatience on his part, or aught but courteous helpfulness.—A. Brazier Howell, *Alna, Maine.*

In the early years of all of us who have given the efforts of our lives to systematic zoology, there stood out certain *colossi*—the great minds, the brilliant scholars, often many-sided, and occasionally as much botanists as zoologists. At the turn of the century it was my privilege to meet, to work and collaborate with, and in succeeding years frequently to consult, Gerrit S. Miller, Jr. From these many contacts, maintained actively over some years, there developed an appreciation of the man and his stature, as attested increasingly by the scholarly and lasting character of the many studies that came from his pen. In sum total these contributions have always impressed me as the greatest made to mammalogical science by any fellow-American of our times, while in clarity of reasoning and in the analysis of their evidence they remain unsurpassed.—James A. G. Rehn, *The Academy of Natural Sciences of Philadelphia.*

BIBLIOGRAPHY OF GERRIT SMITH MILLER, JR.

By Gerrit S. Miller, Jr., and David H. Johnson

[With characteristic precision and orderliness, Gerrit Miller cataloged his published papers throughout the sixty years of his active scientific work. This final assembling of his bibliography has therefore been a comparatively simple matter. The published list of his earlier papers (no. 272 in the present list) has required only minor editorial changes, and a cumulative manuscript list of the later papers was available in Mr. Miller's files. All citations have, however, been verified by reference to the original publications, and some small errors have thus been eliminated. The dates of publication are as nearly correct as can be determined. This is a matter about which Mr. Miller has always been meticulously careful; he never hesitated to investigate the accuracy of a publisher's date if there was any hint of doubt.

A complete bound set of his publications, interleaved with pertinent reviews, correspondence, photographs, and other miscellaneous data, is included in the library that Mr. Miller recently presented to the Division of Mammals of the U. S. National Museum.

The scope of his work in mammalogy, embracing virtually all groups of mammals and all parts of the world; his ability to correlate his favorite fields of systematics and nomenclature with the diverse fields of anthropology, psychology, evolution, and paleontology; his love of field as well as museum work; his amazing facility with foreign languages—all these are shown in the listing of titles presented here. The colleagues who have read his papers, worked with the same

materials, and used his contributions as foundations for newer studies are well aware of the high standards of science and scholarship that he maintained.—D. H. J.]

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FURTHER EVIDENCE ABOUT THE BARREN-GROUND GRIZZLY BEAR IN NORTHEAST LABRADOR AND QUEBEC

By C. S. Elton

Several nineteenth century travellers in the northern parts of Quebec Peninsula have mentioned reports by Indians about the presence of a kind of bear different from the common black species (*Ursus americanus*). The latter is well known to have been and still be common in the forest belt of northern Quebec, and white men have frequently seen them alive or traded their skins. But no white man has ever certainly seen alive the larger barren-ground grizzly bear to which the native reports referred. Taxonomists have mostly either shelved the question of its existence and identity, or supposed it to be a colour variety of the black bear.

The present paper adds some more concrete evidence obtained by me about 18 years ago from two independent series of fur returns. It also summarizes the relevant evidence from other sources. The fur returns have not been published before (except in so far as McLean referred to the matter in general terms in his book about a hundred years ago). The other sources have mostly been mentioned by one person or another, but their significance is greatly strengthened when the statements are taken in conjunction with the fur evidence. There are also some items which have not, as far as I know, been cited, and even McLean's book has not been much noticed in literature about mammals.

John McLean was a Hudson's Bay Company man who was sent to take charge of the Ungava District, his base being at Fort Chimo (Elton, 1942, Part 4). This post had been properly opened in 1830, and McLean was there from 1837 to 1842, when the post was closed. He was a very remarkable traveller, among his exploits being an inland journey to Hamilton Inlet during which he discovered the Grand Falls of the Hamilton River. This was, however, not his only journey to the interior. After retiring, he wrote a book (1849) which proved him to be a very good observer. This impression is strengthened by an unpublished Report on Ungava District for 1837–1838 (in the Archives Library of the Hudson's Bay Company) which vividly describes the geography, geology, forests, animal and bird life, climate, life of the natives, the fur trade and some of his explorations.

In his book McLean says that "black, brown, grisly and polar bears" occur in the District. The Report also includes among a list of animals, "Black, Grissle, Arctic" bears. (The fact that his book has a note on the presence of lemmings—which were not then thought to be of any interest to the fur trade itself—indicates his eye as a general naturalist.) The book (Vol. 2, Ch. 8) goes on: "When we consider the great extent of country that intervenes between Ungava and the plains of the 'far west', it seems quite inexplicable that the grisly bear should be found in so insulated a situation, and none in the intermediate country; the fact of their being here, however, does not admit of a doubt, for I have traded and sent to England several of their skins. The information I have received from

the natives induces me to think that the varieties of colour in bears mark them as distinct species, and not the produce of the same litter, as some writers affirm. Why, otherwise, do we not find the different varieties in Canada, where the grisly bear has never been seen? . . ." ("Canada" here has the limited meaning it bore at the time McLean was writing, i.e. roughly speaking, the area between the meridian of 62° (from a point on the north coast of the Gulf of St. Lawrence, opposite the east end of the island of Anticosti) and the extremity of the peninsula between Lakes Huron and Erie, on a line running N.N.E. and S.S.W.).

Some fur returns for Ungava District for Outfits 1838 (= season 1838–39) and 1839 (= season 1839–40) have survived. 1838 gives one black bear skin, and 1839, one black and four grey bear skins. The latter confirm McLean's statement that he had sent home "grizzly bear" skins, as three of the grey went to England, the other being kept for sale in Canada.

Additional support for these being grizzly bears or something resembling them, is the fact that McLean spent three or four years immediately before coming to Ungava serving at posts in the New Caledonia (i.e., British Columbia) District. In his book (Vol. 1, Ch. 21) he speaks about the different bears found in New Caledonia ("grizzled, black, brown, and chocolate: numbers of them are taken by the native in wooden traps.") And in the Ungava section he mentions some of the habits of black and grizzly bears, based probably on what he learned in the Rocky Mountains. In summary: McLean must have known what he was talking about, and his evidence is most unlikely to be fanciful.

There is some quite independent evidence for this period from the fur returns of the Moravian Mission posts along the coast of Northern Labrador, 1835–1925 (for which, in general, see Elton, 1942, Part 3). There was a fairly constant though small, supply of bear skins from some of these posts, most of which must have been either "black" bears (or their colour variety, "brown") or polar bears (classified as "white"). The different kinds are not always separated in the fur returns, but a sufficient number of special notes were made to prove that black, brown, grizzly or grey and white bears were all taken at various times. The following are the significant facts about the brown and grizzly skins: Season 1835–36, 4 Grizzly bears (1 Hebron, 1 Okak, 1 Nain, 1 Hopedale) @ 14s. each, Black bears @ 4s. each; Season 1836–37, 3 Grizzly bears (Hebron) @ 25s, Black @ 14s; Season 1837–38, 1 Grey bear (Hebron) @ 18s, 1 Brown bear @ 13s (Nain), Black @ 15–16s.

These bears were taken at about the same time that McLean was noting them from the other side of N.E. Labrador. Further Moravian Mission records are: Season 1851–52, 2 Grey bears (Hebron) @ £1. 2. 6d. (cf. 2 "Bear" @ 15s); Season 1854–55 1 Brown bear (Hopedale) @ 10s. (cf. 5 "Bear skins" @ £1. 11. 0. each); Season 1856–57 1 Grey bear (Hebron) @ £1. 2s. (cf. "Bears" @ 7.3d. & 7.6d.); Season 1858–59 1 Grey bear (Hopedale) @ £1. 5. 6d.; Season 1862–63 1 Grey bear (Okak) @ £2. 6s. (cf. "Bears" @ 16s), 2 Brown & 1 black (Nain, prices not given), 1 "Bear" (Hopedale) @ £2.; Season 1913–14 1 Grizzly bear (no other information); Season 1925–26 1 Brown bear, medium size, 10s.

In 1923 a brown cub bear skin was brought home by a Mission official (Mr.

FIG. 1.—Map of Quebec Peninsula. Black dots are present (and some former) fur posts. Dash line is approximate tree-limit.

Pennington, who told me this), almost certainly either from Hopedale or Nain, and recently caught.

These records are all that could be found about "grizzly", "grey" or "brown" bears in the Mission records. The "Periodical Accounts of the Moravian Missions" contain no relevant facts about bears, which were a very minor element in the trade with natives. But the general heading "Bear" in the fur returns for other years after 1866 possibly conceals further occurrences of forms other than black bear.

There is no further information from other sources until quite late in the nineteenth century.

Bell (1884) who went on Lieut. A. R. Gordon's expedition of 1884 as medical officer, obtained information from various residents along the Northern Labrador coast (e.g., at Nachvack, north of Hebron) and Hudson Strait. "Barren-ground Bear, *Ursus arctos* (Richardson). This bear is found in the barren grounds south of Hudson's Strait. Capt. William Kennedy, who was formerly agent of the Hudson's Bay Company in the Ungava District, informed me that the skins

they got there resembled those of the grizzly bear closely enough to pass as a variety of this fur in the trade. Some of the Hudson's Bay Company's officers regard the barren-ground as a variety of the cinnamon, bear. In the barren grounds to the north-west of Hudson's Bay, I have been told that a large bear is found, which the Eskimo consider a variety of the polar bear, which has adopted a terrestrial life, and to which they have given the name of 'blue' or 'grey' bear." Bell's information is second-hand, but nevertheless fairly definite. Turner (1887), a very thorough and careful ethnologist who spent the years 1882–84 at Fort Chimo investigating Indian life, noted that the black bear "rarely ranges beyond the woodlands, never being found so far north as Fort Chimo", and that "The brown or barren-ground bear appears to be restricted to a narrow area and is not plentiful, yet is common enough to keep the Indian in wholesome dread of its vicious disposition when enraged." (pp. 174–5).

It will be noticed that Turner's bear was brown, not grey. Fort Chimo had been reopened in 1866, but thereafter no grizzly or grey bear skins appeared in the fur returns. Turner's note evidently applies to the animal as seen alive by Indians.

Low (1896) who travelled extensively in this region and was a first-class scientific geologist and general observer, said of the Koksoak River valley: "Black bears are very rare, and specimens of the barren-ground bear are obtained only at infrequent intervals" (p. 122 L). In more general terms for north-east Quebec Peninsula he makes these notes (p. 316 L): "*Ursus arctos* Richardson (Barren-ground Bear). There is no doubt that this species is found in the barrens of Labrador, as skins are brought in at intervals to Fort Chimo, and the Nascopie Indians have numerous tales of its size and ferocity" . . . "*Ursus americanus* Pallas (Black Bear). The wooded country is the northern limit of this species, and it is most abundant in the southern region in the burnt districts. At Cambrian Lake, on the Koksoak River, the tracks of a large bear were seen along the shores but it is not known whether these were those of a black bear or a barren-ground bear." Except that Low assumed the reputed bear to be Richardson's barren-ground bear, he says nothing about the colour. I believe his statement that (apart from any polar bears) non-black skins came occasionally to Fort Chimo, though they do not figure separately in the fur returns.

Dillon Wallace (1906) obtained some further evidence from fur-traders. He and his companions stayed at Fort Chimo through part of the winter of 1905–6, and subsequently made their way, *via* George's River post and the George's River valley to Hamilton Inlet. He says: "There is a story of a very large and ferocious brown bear that tradition says inhabits the barrens to the eastward toward George River. Mr. Peter McKenzie told me that many years ago, when he was stationed at Fort Chimo, the Indians brought him one of the skins of this animal, and Ford at George River said that, some twenty years since, he saw a piece of one of the skins. Both agreed that the hair was very long, light brown in colour, silver tipped and of a decidedly different species from either the polar or black bear. This is the only definite information about it that I was able to gather. The Indians speak of it with dread, and insist that it is still to

be found, though none of them can say positively that he has seen one in a decade. I am inclined to believe that the brown bear, as far as Labrador is concerned, has been exterminated."

The note by Stirling (1884), to which Allen (1942) refers, is not very useful. It consists of a long quotation from McLean's book, part of which has already been given here. But he gives some additional information not contained in that book, though running on as part of the quotation, which is difficult to interpret.

Hesketh Prichard (1911: 61) met with several black bears in the woods inland from Nain, during his traverse to Indian House Lake in 1910. He makes the statements that "tradition gives this place as the spot where, in 1894, an Indian killed the last recorded specimen of the red or barren-ground bear" (p. 101); and that "the red or Barren Ground bear is probably extinct in *explored* Labrador" (p. 233; his italics).

Strong (1930), who travelled with the Davis Inlet band of Indians in 1928, has discussed some of this evidence. Although his Indians recognized by a special name a brown bear different from the black, they were evidently unable to distinguish in their minds between a barren-ground bear and the brown phase of the black bear. None of these people (who he states, ranged from Ungava to Hamilton Inlet) had ever *seen* either form. Strong therefore inclined to assign their *méh-ta-shue* to a traditional story of the brown phase of *Ursus americanus*. But he himself does not seem to have read McLean's book.

The Rev. F. M. Grubb, who had good experience of the Moravian Mission post at Nain, gave me some useful information in 1934. He knew the black bear well, but the Esquimaux told him that there was also a grey bear that is savage. He had no further information about it. His natives hunted far inland on the plateau in winter, going as far as Indian House Lake—that great expansion of the George River that was a famous caribou crossing place in former days.

The Rev. George Harp of the Hebron Mission told me in 1945 that he had received no reports or skins of grizzly bears during his twenty years residence, mostly at this post. But his natives did not penetrate much into the area where these bears might live.

For my last positive bit of information I am indebted to Mr. Tom Manning who wrote (October 4, 1948) as follows:

"I promised to try to find out more about the 'brown' bear that was seen by the crew of an R.C.A.F. survey Canso on the Barren Grounds of Ungava, but there appears to be little more information than I already gave you. I recently met the navigator on that flight, and he, like the pilot to whom I had spoken earlier, could not remember exactly where they saw it, but think probably it was a hundred miles or so northwest of Chimo. Certainly it was on the barren ground, but probably not a great distance from the trees. They were quite convinced that it was not a polar bear, and certainly any of these that I have seen from the air look quite white, although I believe they have been known to roll in mud on occasion."

The chief points that come from this evidence are: (1) A species of bear not the typical black or the polar bear was living in north-east Labrador and Quebec

in the nineteenth century. (2) It inhabited tundra country rather than the forests, though there is really no very clear line in this region that could be termed "the tree-limit", only a gradual disappearance of woodland. (3) By those who handled its skins it was described as a brownish-grey, grey, or grizzly bear; by those who reported it from Indian sources in the late nineteenth and early twentieth centuries it was called brown (and in one instance red). (4) There are two reports in the twentieth century (1914, 1948) that might refer to it, the first of a grizzly skin, the second of a live brown bear.

I therefore state the probability that an eastern population of some bear of the barren ground grizzly group lived in this area and may still survive there. There are, however, some points that need further discussion.

The two main things we want to know are over what area this bear ranged, and what species is concerned. The map shows the six points (Fort Chimo, Georges River, Hebron, Okak, Nain and Hopedale) at which skins have ever been received from natives: these and the reports quoted above suggest a normal limitation to an area within the north-eastern triangle of Quebec Peninsula, between the Koksoak River and the Labrador coast north of Hamilton Inlet. Restriction to the northern Barren Grounds would give a triangle bounded roughly on the south by a line from Fort Chimo to Georges River post and thence to Hebron and Okak.

The fur figures, though very small, show the skins in the following frequency: Hebron 8, Okak and Chimo 2 each, Nain 1, Hopedale 2. The Hebron skins came in 5 separate years. We do not know the exact source of the 1914 skin.

There is no evidence in the Periodical Accounts of the Moravian Missions of any visits of Indians to Nain or Hopedale in the season 1835–36, when one grizzly skin was sent from each of the four posts then in existence in Northern Labrador. They must therefore be assumed to have been collected by Esquimaux hunting from each of these posts. The unusual length and heavy snowfall of the winter 1835–36 was specially noted by the missionaries. It is just possible to account for the south-eastern occurrences of grizzly skins by some unusual movement of bears in search of food. For instance, at Hebron snowdrifts were very deep and did not disappear until June, while at Hopedale the growth of garden vegetables in August was about equal to the usual growth by early June. Drift-ice persisted very late along the coast. It certainly seems unlikely that the skins were handed from one Esquimaux colony to another before being traded to the Mission posts.

The Hopedale record of one grey bear in 1858–59, could not be explained in the same way, as the spring was a rather early one. But we do know that a band of Hopedale Esquimaux visited Okak in March, 1859, and subsequently returned. There is just a possibility that the bear skin was brought from further north. If not, we must conclude that in these early days barren-ground grizzly bears occasionally wandered some hundreds of miles south of their normal range.

Without expecting to explain the Nain and Hopedale records more exactly, we may reasonably take the centre of distribution of the bear to lie in that northern triangle that has always been the least visited by human beings of any race.

Its complexity and the natural obstacles to ground travel may be understood from the air photographs taken by Forbes (1938). Mountains several thousand feet high are common near the coast, and the terrain is rugged and practically treeless. "The timbered slopes may be seen as far north as Nain; but beyond that point the growth of evergreens rapidly becomes sparser, until the last of it is left behind in the vicinity of Cape Mugford. Farther north only dwarf birch and willow are found, and these diminutive trees decrease in size until, on the shores of the fjords among the Torngats, they rarely grow more than a few inches above the ground. The mat of dwarf trees is mingled with grass and sedges to make a green carpet among the bare rocks . . ." (Forbes 1938: 6–7). The Torngat Mountains fill the northern tip of this extremely wild and partly unexplored region. The possible barren ground area for the bear would be an almost equilateral triangle with sides in the region of 200 miles long i.e. an area of, say 20,000 square miles. This is not an unreasonable preserve for even such a large animal as a bear.

The map of the normal territories of Indian Bands since 1850 compiled by Speck (1931: 14) puts the northern limit of the so-called Barren Ground Band approximately along the southern limit of this triangle, with Esquimaux occupying the coastal zones. The two neighbouring bands are the Ungava Band south and west of Fort Chimo, mainly west of Whale River (not east as stated in error by Elton, 1942: 250); and the Davis Inlet Band, south-west of the Barren Ground Band. The triangle in which we suppose these bears to have been living therefore has been visited seldom either by fur-hunters or ground explorers, except perhaps on occasional distant journeys after caribou. Nevertheless it seems certain that this country, though very inhospitable to man, contains resources on which bears could live: forage, berries, small rodents, fish, and caribou. The caribou have fluctuated in numbers and distribution very much (see Elton, 1942: Ch. 18), but it would seem that there have always been some deer there at certain times of the year.

Although the evidence as a whole points clearly to this northeastern triangle, it should perhaps be explained that that of McLean from Ungava taken by itself does not define the range at all exactly. The Indian bands visiting Fort Chimo in the 1830's wandered widely, sometimes going to the posts on Hamilton Inlet or even the Gulf of St. Lawrence; while some Indians came to Chimo from Eastmain, on Hudson's Bay. But I have no evidence of any barren ground bears ever having been seen in, or their skins traded from, the regions between the Koksoak River and Hudson's Bay.

Assuming the existence of an unidentified bear in the Barrens of northeast Quebec Peninsula, can we with the available evidence come near any exact identification of the species? The three possibilities are that it is (1) a colour phase of *Ursus americanus* Pallas, (2) a true grizzly bear e.g., *U. horribilis* Ord, or (3) a barren-ground grizzly bear e.g. *U. richardsoni* Swainson. Unfortunately for the ordinary biologist, the taxonomy of many American bears has been mainly described from the craniology, often of only a few specimens. As is well known, this process was carried to its extreme by Merriam (1918). Allen (1942),

in reviewing the status of extinct and vanishing mammals in the Americas, gives a useful summary of the taxonomic groups of North American bears. Anderson (1945) has recently reviewed the Canadian forms of *Ursus* (*"Euarctos"*) *americanus*. But it is not easy to discover what are the exact seasonal changes in quality and pelage, especially of the grizzly bears (*sensu lato*). Rausch (1953) has examined available material for Alaskan grizzly bears and has concluded that "a single, but highly variable, species of grizzly bear occurs in Alaska", and furthermore that "a single species of bear extended across the entire North American Arctic." This conclusion, if correct, will only affect the discussion given in the present paper, in-so-far as it would make Richardson's barren-ground bear a form of grizzly rather than a separate species.

There appears to be no grizzly, i.e., silver-tipped brown or yellow colour phase of the black bear, though there is a local variety (*emmonsi* or *emmonsii*) called the "glacier bear", in Alaska, which is bluish-grey and rather small. Various brown or yellowish-brown forms, known to zoologists usually as the "brown" or "cinnamon" phase, and to the fur trade as "brown", are well known. They appear to be much commoner in western than in eastern Canada. They are dimorphic or polymorphic varieties within the species.

Brown bears have occurred in Quebec Peninsula, as the fur trade records for wooded areas show. But, as Anderson states, they are very rare in eastern Canada: "we have only one record, a male cub of bright cinnamon colour trapped . . . 1935, seven miles North of Montebello, Labelle county, Quebec." This is in the main confirmed by the Hudson's Bay Company fur returns that I have examined. In the James Bay area brown bear skins have been regularly obtained, though in a small proportion to black ones, at posts such as Fort Albany on the west coast of the Bay. But from Moose Factory and posts eastwards up the coast of James Bay, there are practically no brown skins recorded. Mr. D. C. Bremner, post manager of Fort George, informed me in 1934 that a man at Eastmain had recently taken a "yellow" bear, and that such bears were quite rare.

I have looked at a skin of a cinnamon bear from Fort Albany, in the British Museum (Natural History), taken in 1843. The hairs are predominantly a tawny or yellowish brown most of the way down the hair, with no grey or white tips. But typical grizzly bear skins have black pigment absent from the tips of many hairs in such a way as to leave them yellowish-white in appearance. This imparts a rippling grey sheen that is absent both from the normal black bear and its cinnamon phase. From published accounts, however, many brown *Ursus americanus* are quite a dark glossy brown and not yellowish-brown coloured.

There can, I think, be no doubt that this brown colour phase is very rare in Quebec Peninsula. It does occur every now and then in the Labrador strip of the country (which Anderson presumably did not include in his generalization). There are the Moravian Mission fur records and Mr. Pennington's bear cub. I have the bear fur statistics for the modern Labrador District of the Hudson's Bay Company for the years 1926–27 to 1933–34 kindly supplied to me in 1934.

The only brown one taken was at Rigolet, on Hamilton Inlet. The numbers of black bears taken were Rigolet 38, North West River 127, Cartwright 3, Makkovik 12, Hopedale 28, Davis Inlet 112, Nain 80, Nutak (= Okak) 15, Hebron 5: total, 420 in eight years. No grey bears were received.

In 1933 the Rev. W. W. Perrett, Moravian Missionary at Hopedale, wrote to Mr. Madison Grant of the New York Zoological Society (for permission to quote I am indebted to the late Dr. W. Reid Blair), that a brown bear was trapped in the summer of 1931, in Kanagektok Bay, just south of Hopedale. Mr. Perrett obtained the skin and skull which was sent to a friend in New York. "This is the first brown bear I have come across in Labrador and the natives say they are not often seen. For any one who was not on the look out it might be passed as rusty black bear, and maybe this is the reason so few records of its appearance have been made." Mr. Perrett had a long experience at the post and was an authority on the Eskimo language.

The fact that the Labrador "grizzly" skins were distinguished as such by men who knew both the true grizzly and the brown bear skins; its reputed distribution in the Barrens, where *Ursus americanus* does not ordinarily wander; and the reports of its larger size, are reasons for dismissing the brown phase as an explanation of the Labrador reports.

The true grizzly bear of the Rocky Mountains and neighbouring plains, also called "silver-tip", is usually identifiable by having a number of the yellowish tips of the hairs lacking black pigment. This produces a rippling greyish lustre on parts of the body, whose fur is basically brown or yellowish-brown. Professor I. McT. Cowan, who has had considerable experience of grizzly bears in British Columbia, has kindly given me some information about the pelage variations and seasonal changes. There is a very great variability in colour, the typical grizzled form being only one of a number of colour phases. Thus, the grizzled type is rather rare on the coast of British Columbia, the majority being dark brown. In the northern interior of the province, the commonest colour is golden brown with ears and lower legs black. But in the Rockies and presumably in earlier years on the edge of the Plains, the grizzled is the commonest, though even in this section of their range dark or buff forms occur. In-so-far as the Labrador bear does apparently show grizzled fur in the winter at least, these non-grizzled forms do not affect the interpretation of the Labrador evidence. Professor Cowan says: "To my knowledge the only time that a grizzled phase grizzly does not show the tips clearly is when the new pelage is very short, i.e., in July or August. By September and October grizzlies are in good colour. The moult starts in British Columbia in late June. During July most bears are very ragged. I have seen a large very brown grizzly in, I think, the first week of August, clean moulted. They bleach fast in the early spring and it is then that the silver tipping is intensified by the effect of bleaching." It will be seen, from the description of Richardson's barren-ground bear below, that the greyish brown grizzlies have their grizzle for most of the year, whereas the barren-ground bear seems to have it for a shorter period. This difference makes the latter species fit the Labrador evidence better than the former. But, nevertheless, Professor

Cowan points out that the former eastern limits of the true grizzly bear are not yet certainly known, and that the species appears to have extended at least as far as Manitoba. This makes the migration of *U. horribilis* into Quebec Peninsula in former times a possibility, though perhaps an unlikely one.

Richardson's barren-ground bear is a large brown or brownish bear that lives in the Barren Grounds of the Western Arctic, north of the tree limit. During the northward shift of life zones following the retreat of the final glaciation of North America, it might have split into two populations west and east of James Bay and Hudson's Bay. This assumes that it was spread across the continent in Holocene times, and that in its eastern area it only survived in the Barrens east of Ungava Bay, becoming extinct in the north-western part of Quebec Peninsula.

As regards the fur categories of bears used by the Hudson's Bay Company, there is a plain statement by Macfarlane (1908: 215), one of the great fur traders and naturalists of the Mackenzie River region. Of *Ursus horribilis* he says: "Comparatively few skins of this bear are received from the Indians, and they, together with most of those of *U. richardsoni*, figure under *gray* in the Company's accounts." This makes it reasonable to suppose that the Labrador grey bears could have been listed on the same principle.

According to personal information from Mr. J. S. Tener, who has observed the animal in the Western Arctic, Richardson's bear is not very often seen by biologists, and much remains to be found out about its ecology and the seasonal changes in its pelage. It was first described by Sir John Richardson, from his observations during Franklin's First Expedition. He distinguished it clearly from the true grizzly bear and the black bear. "The barren lands, however, lying to the northward and eastward of Great Slave Lake, and extending to the Arctic Sea, are frequented by a species of Bear, which differs from the American Black Bear in its greater size, profile, physiognomy, longer soles, and tail; and from the Grisly Bear also, in colour and the comparative smallness of its claws. Its greatest affinity is with the Brown Bear of Norway; but its identity with that species has not been established by actual comparison." (1829, Vol. 1: 21). He accordingly named it provisionally "*Ursus Arctos? Americanus.* Barren-ground Bear," *arctos* being the European species. In 1838 Swainson named it *U. richardsoni*, mainly from Richardson's original accounts. The notes by Bell and by Turner, quoted earlier, use the name *Ursus arctos* and were here presumably following Richardson's monograph. There can be no doubt they were intended to refer to the barren-ground bear.

Richardson gave the general colour as dusky- (sometimes yellowish-) brown, "but the shoulders and flanks are, in the summer season at least, covered with long hair which is frequently very pale towards the tips." He also described one old male taken in August in more detail: "Nearly uniform yellowish-brown colour, except on the forehead and back, where the tips of the fur were paler. The fur . . . was giving place to a thin coat of blackish hair."

Preble, Anderson and Clarke have a few notes that suggest a more or less grizzled fur during part of the year. Samuel Hearne at the end of the eighteenth

century "saw the skin of an enormous grizzled bear at the tents of the Eskimo at the Bloody Fall, Coppermine River." (Preble, 1908: 224). J. M. Bell wrote to Preble of the "grizzly bears, large grayish-brown brutes" that he saw near Great Bear Lake. A June specimen taken by Macfarlane east of Fort Anderson, McKenzie River barrens, in 1864 (now in the U. S. National Museum) had a dull yellowish brown skin. Preble says: "It resembles closely some specimens of the grizzly bear, but the head is more yellowish." (*Ibid.*: 225).

The Canadian Arctic Expedition collected rather a large number of specimens, especially in the region between Great Bear Lake and the northern ocean, along the Horton River and round Langton Bay. Anderson (1913: 519–22) says his party killed about twenty there. He gives some notes on the habits and appearance of the species, which he considered might contain two or three different forms. The chief points about their habits are that these bears are wary but not savage except when wounded; they live to a great extent on plant roots in summer—either dug or stolen from ground squirrel stores; and they hibernate from early October to early April, only going abroad exceptionally in winter. Not much information is given about the colour. Two skull types were distinguished—long-snouted and short-snouted. The former were more reddish brown or bay, the latter often very dark,—"dusky brown, with tips of hairs on dorsal surface light grayish brown on fulvous, sometimes with tips a faint golden yellowish tint. But Anderson notes that "it is rather hard to distinguish them by colour, as late summer skins are usually much bleached out."

Clarke, in his report on the Thelon Game Sanctuary (1940: 32) says: "In 1936 there was at Reliance a skin and skull of the barren ground bear, the property of Mr. George Magrum, one of the barren ground white trappers. The bear was shot at Outram Lakes in August, 1935, and was in a short, very dark pelage except for an unshed area of bleached winter fur along the back." (The specimen is in the National Museum of Canada.)

The present distribution of this species in the Western Arctic is scattered over the Barren Grounds between the Mackenzie River and Hudson Bay, though it has not yet been reported near the coast of the Bay itself.

One more piece of evidence merits discussion. It may be seen that the Moravian Mission grey and grizzly bear skins consistently fetched higher prices than black or brown bear skins taken in or about the same years. I thought this might be confirmatory evidence of the greater size of the grizzly skins, and therefore examined a series of sale prices of bear skins sold at London auctions of the Hudson Bay Company, to see if this notion was borne out. Both in the earlier sale years, (1837–40) and the later ones (1858–60) the prices fluctuated widely as between different types of bear (black, brown, and grey), and even between sale lots of the same species bought by any firm in the same auction. These differences no doubt were partly due to age, size and condition of the bear skins, but evidently also to vagaries of the auctions. Taking only the *maximum* prices, the grey bears were usually lower than either the black or brown. It is evident therefore that we can place no great reliance on the Moravian Mission prices as an index of species.

Acknowledgements.—I am grateful to the following who have helped me in this enquiry: the Governor and Committee of the Hudson's Bay Company, and the Moravian Missions, for permission to make use of unpublished material from their archives, and for other help; Professor I. McTaggart Cowan and Mr. John S. Tener for information about the species of Canadian bears and for kindly reading parts of this paper in manuscript; Mrs. Phoebe Jackson and Mrs. Mary Nicholson for assistance in studying the archives some years ago; and several others, whose information is mentioned in the paper.

SUMMARY

Reports from natives, fur-traders and explorers about the existence of a species of large bear of the grizzly type in north-eastern Labrador and Quebec are supported by evidence from early fur returns of the Hudson's Bay Company and the Moravian Missions. It is concluded that a species different from *Ursus americanus* existed and may still exist in that region, and that it is probably the barren-ground grizzly bear (*Ursus richardsoni*), hitherto known only for certain from country west of Hudson Bay. It is also confirmed that the brown or cinnamon phase of *Ursus americanus* is extremely rare in Quebec Peninsula.

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THE OS CLITORIDIS OF SOME NORTH AMERICAN SCIURIDAE

By James N. Layne

Descriptive studies of the mammalian os penis or baculum are numerous, and its value as a systematic and age criterion has been recognized. Its homologue in the female, the os clitoridis or "baubellum" (Shortridge, 1934), has apparently been only sporadically studied, and it actually occurs more widely than is often suspected. It has been recorded in the literature from the orders Chiroptera, Primates, Rodentia, and Carnivora in at least the following genera: *Rhinolophus*, (Simokawa, 1938); *Galago* (= *Hemigalago*), (Pocock, 1918); *Symphalangus* (= *Siamanga*), (Gerhardt, 1909;) *Pongo* (= *Simia*), (Gerhardt, *ibid.*); *Aplodontia*, (Scheffer, 1942); *Sciurus*, (Sierts, 1950, Simokawa, *op. cit.*); *Tamiasciurus*, (Layne, 1952); *Eutamias*, (Simokawa, *op. cit.*); *Mesocricetus*, (Callery, 1951); *Mus*, (Simokawa, *op. cit.*); *Hystrix*, (Weber, 1904); *Cavia*, (Simokawa, *op. cit.*); *Cryptomys*, (Thomas, 1917); *Ursus*, (Jellison, 1945); *Thalarctos* (= *Ursus*), (Owen, 1868); *Procyon*, (Rinker, 1944); *Mustela* (= *Ictis*, *Putorius*), (Pohl, 1909, Simokawa, *op. cit.*); *Martes*, (Jellison, in Scheffer, 1949); *Lutra*, (Scheffer, 1939); *Cryptoprocta*, (Lönnberg, 1902); *Felis*, (Simokawa, *op. cit.*); *Panthera* (= *Felis*), (Retterer and Neuville, 1913); *Callorhinus*, (Scheffer, 1949); *Zalophus*, (Sierts, *op. cit.*); *Phoca*, (Owen, *op. cit.*, Scheffer, 1949). I have also observed it in *Eptesicus*, *Geomys*, and *Urocyon*, and its occurrence in *Nasua* has been reported by M. Hildebrand (personal communication).

The present study attempts a survey of the os clitoridis within the North American Sciuridae with the aim of determining its frequency of occurrence, relative constancy of shape and size, and possible use as a taxonomic and aging device. The penis bones of sciurids have been studied by Thomas (1915), Pocock (1923), Wade and Gilbert (1940), and Didier (1952).

Acknowledgement is made to the following persons who allowed me to examine specimens in their care: Rollin H. Baker, Museum of Natural History, University of Kansas; William H. Burt, Museum of Zoology, University of Michigan; D. Dwight Davis, Chicago Natural History Museum; Howard K. Gloyd, Chicago Academy of Sciences; Milton Hildebrand, University of California (Davis); Thane S. Robinson, State Biological Survey, University of Kansas; and Philip W. Smith, Illinois Natural History Survey. Particular thanks are

due Professor William J. Hamilton, Jr., Cornell University, for helpful criticism and valuable suggestions.

MATERIALS AND METHODS

Eighty-two specimens of eight genera and 28 species have been available for study. The majority of these were obtained from freshly killed animals and formalin or alcohol preserved material. A section of the vulva containing the clitoris was cut out, macerated in a 2 per cent solution of potassium hydroxide, then cleared in pure glycerin. Fresh specimens could be examined in one or two days, but preserved material took longer to clear. The advantage in clearing the bones *in situ* lies in the fact that they can be initially examined in essentially their original orientation and when closer study is required can be easily dissected from the jellified tissues without damage to delicate structures. The bones were subsequently examined and stored in glycerin. Some individuals of *Marmota* and *Citellus*, regardless of age, have a clitoris bone that appears entirely cartilaginous although similar in size and shape to the usually osseus structure. This may occasionally be the result of decalcification by the preservative, but it is also probable that there are some individuals in which the structure remains cartilaginous throughout life.

In addition to the cleared preparations, an excellent series of 28 dried and carefully mounted clitoris bones was received for study through the courtesy of William H. Burt. Although very useful, dried specimens do not show the finer details of structure revealed by cleared examples since they may be damaged during dissection or drying or have vestiges of dried tissue adhering to them.

For descriptive purposes the os clitoridis is considered oriented in the same way as the os penis. In the majority of the forms studied this relationship is approximated, but in the case of *Citellus* the os clitoridis in cleared specimens is invariably rotated almost 90 degrees from the position of the baculum. Where it is not possible to correlate the position of the bones in the two sexes because of marked differences in shape, the orientation of the os clitoridis in the fresh, preserved, or cleared vulva is assumed to be approximately that of the os penis when the clitoris is considered to lie parallel to the body axis with its distal end directed cephalad.

In the descriptions the expression "relative length" refers to the *size of the os clitoridis as compared to that of the baculum* and is obtained by dividing the length of the largest os penis as given by Wade and Gilbert (*op. cit.*), Howell (1938), or taken from specimens in the Cornell University collections, into the length of the largest os clitoridis available for the particular species. The term "subadult" refers to nulliparous animals while "adult" denotes an animal that had bred or was in breeding condition when collected. The number of specimens measured and examined, when more than one was available, is given in parentheses following the description of the measurement.

Howell's (*op. cit.*) classification has been adopted with the realization that certain modifications in the number of genera recognized have been proposed by Bryant (1935) and Ellerman (1940).

DESCRIPTIONS

Marmots. *Marmota monax rufescens* Howell.—The os clitoridis (Fig. 1,A) is a slender, slightly curved spicule which is thickest at its base and usually slightly expanded distally. The base is often oblique where it attaches to the corpora cavernosa. Variation occurs in the amount of curvature and thickness of the shaft and the degree of expansion at the tip. Most subadult examples are decidedly more slender and smaller, with the base appearing relatively thicker. An adult and a yearling specimen are cartilaginous. Length: adults (6), 2.5 mm. (1.5–3.3); subadults (2), 2.0 mm. (1.8, 2.2). Relative size .49.

Prairie dogs. The general similarity of the os clitoridis of *Cynomys* to the *Citellus* type rather than *Marmota* is as distinct as that pointed out by Wade and Gilbert (*op. cit.*) for the bacula of these genera. Neither of the two species of *Cynomys* examined shows any close resemblance to the bacula of the corresponding males, but they differ noticeably from each other as do the male bones.

Cynomys ludovicianus (Ord).—A dry specimen (Fig. 1,B) is relatively unspecialized. The shaft is laterally compressed and curves inward more on the right side than on the left. It expands distally into a narrow disc with a trough-like depression on its dorsal face. A small foramen is present at the termination of the furrow. The margins of the disc are minutely crenulated. Length 2.6 mm. Greatest width of scoop .7 mm. Relative size .56. Two specimens from young of the year collected June 30 are quite different from each other. One (length 2.1 mm.) resembles the dried example except that the trough on the disc is shallower, the margin of the disc is entire, and there is a spur-like projection on the ventral margin of the shaft where it joins the disc. The other (length 1.5 mm.) is a stout rod-like element which is only slightly widened and flattened distally.

Cynomys leucurus Merriam.—As in the male (Wade and Gilbert, *op. cit.*) an example of this species (Fig. 1,C) is somewhat more modified than *ludovicianus* and slightly smaller. It has a slightly twisted shaft which widens terminally into a more distinct disc. There are several blunt teeth on the anterior edge of the disc, and its dorsal surface has a distinct circular depression. The base of the shaft is laterally compressed with a keel-like projection on its ventral side. Length 2.4 mm. Greatest width of scoop .9 mm. Relative size .56.

Ground squirrels. At least one specimen representing each of the eight subgenera of *Citellus* was examined. Although the os clitoridis in *Citellus* tends to be more complicated, there is no clear morphological distinctness between the less modified forms such as *C. franklini*, C. *richardsoni*, and *C. tereticaudus* and the *Cynomys* type. The general structure of the bone in the female as well as in the male ground squirrels is that of a rather slender shaft that usually, but not always, widens distally to form a distinct disc. Generally the shaft is bent at about its middle or at the origin of the disc so that the latter is inflected dorsad. The disc is often concave above and its margin may be entire or armed with teeth or crenulations.

While there exists only moderate similarity between the clitoris bones and the corresponding bacula of those figured by Wade and Gilbert (*op. cit.*), the former appear fairly distinctive for each species examined. In the subgenus *Ictidomys*, represented by *Citellus tridecemlineatus* and *C. mexicanus*, the clitoris bones seem to indicate subgeneric characters, but in the subgenus *Citellus*, of which *C. richardsoni*, *C. armatus*, and *C. columbianus* were examined, there is no apparent basic similarity. The specimens and species representing the remaining subgenera are too few to determine the extent of individual and interspecific variation or whether any subgeneric differences are exhibited.

Citellus (*Citellus*) *richardsoni* (Sabine).—A cleared specimen (Fig. 1,D) is cartilaginous. It has a slender, slightly curved shaft and a narrow, asymmetrical doubly concave disc. No distinct teeth are present on the disc but its margin is interrupted by indistinct projections. The proximal end of the shaft is trilobed. Four dry specimens show considerable variation. One is obviously from a young animal, consisting only of a thin shaft and a simple flat disc. One has scarcely any distal expansion, while another is similar to the specimen figured. The last has a better developed disc than the rest with its margin irregularly beset with

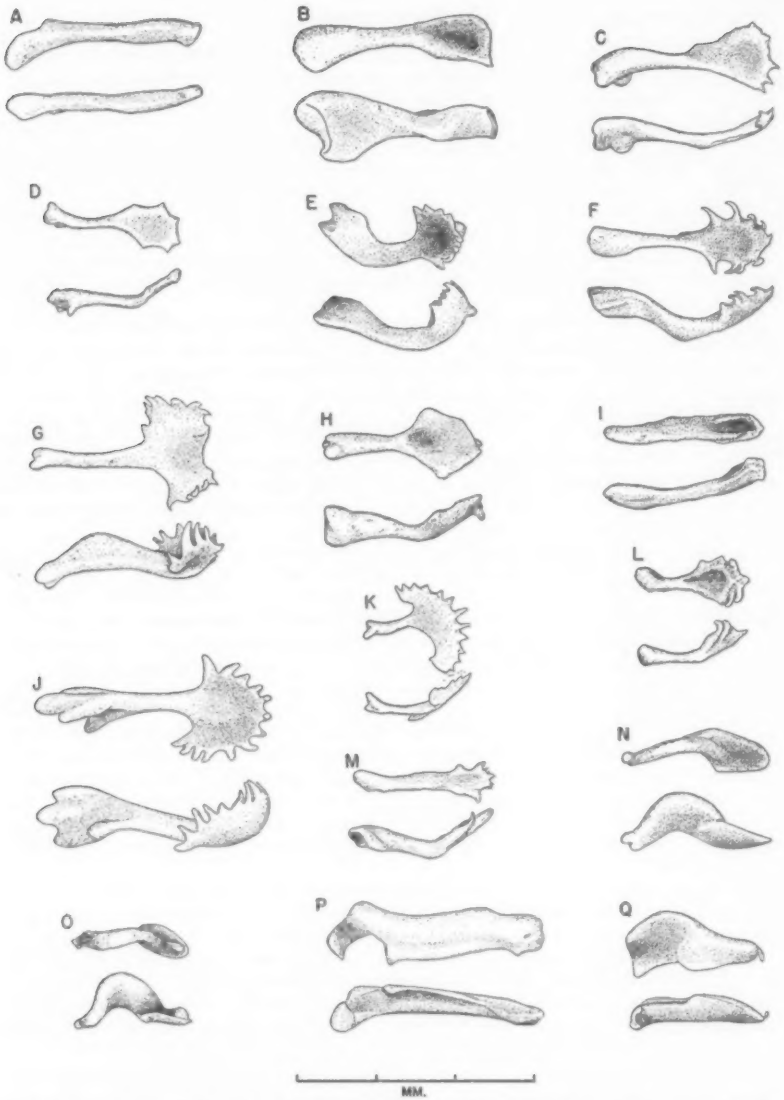

FIG. 1.—Dorsal and right lateral views of the os clitoridis of *Marmota*, *Cynomys*, *Citellus*, *Tamias*, *Eutamias*, and *Glaucomys*. A. *Marmota monax rufescens*; B. *Cynomys ludovicianus*; C. *Cynomys leucurus*; D. *Citellus richardsoni*; E. *Citellus armatus*; F. *Citellus columbianus*; G. *Citellus t. tridecemlineatus*; H. *Citellus franklini*; I. *Citellus variegatus*; J. *Citellus adocetus*; K. *Citellus leucurus*; L. *Citellus tereticaudus*; M. *Citellus lateralis*; N. *Tamias striatus lysteri* O. *Eutamias minimus*; P. *Glaucomys v. volans*; Q. *Glaucomys sabrinus macrotis*.

teeth. The tip of the shaft projects bluntly beneath the disc. Length (5), 1.7 mm. (1.3-2.2). Greatest width of disc .6 mm. (.4-.9). Relative size .50.

Citellus (*Citellus*) *armatus* (Kennicott).—A single specimen (Fig. 1,E) has a strongly curved and flattened shaft and a circular, bowl-shaped disc. Eight fairly distinct teeth line the margin of the disc, those on the right side being sharper than the ones on the left. The shaft terminates as a prominent projection beneath the anterior edge of the disc. Length 2.0 mm. Width of disc .7 mm.

Citellus (*Citellus*) *columbianus* (Ord).—These (Fig. 1,F) resemble *richardsoni* more than *armatus* but have the teeth on the disc better developed than the former. The shaft is bent at about the middle bringing the disc dorsad. The disc is tear-drop shaped and bears prominent, rather regularly spaced teeth on its margin. Its dorsal face is only slightly concave. Length (2), 2.4 mm. (2.3, 2.4). Greatest width of disc 1.0 mm. (.9, 1.0).

Citellus (*Ictidomys*) *t. tridecemlineatus* (Mitchill).—This bone (Fig. 1,G) has a slightly arched and somewhat twisted shaft, which curves upward and enlarges into a dorsally concave disc with wing-like lateral margins. The shaft is compressed throughout its length and distally blends into the ventral surface of the disc with no indication of a terminal projection. Its base is bilobed. The disc has its anterior edge broadly indented and is asymmetrical in that the right margin is smaller than the left. Five to eight slender, curved teeth usually project from the lateral margins. Two subadult specimens have the teeth much reduced. They are short and blunt in one and mere crenulations in the other. The disc in these specimens is also distinctly less concave and appears less expanded. The bone of one adult is cartilaginous but is perfectly formed. Length: adults (2), 2.4 mm. (2.3, 2.6); subadults (2), 2.8 mm. (2.7, 2.9). Greatest width of disc: adults 1.4 mm. (1.3, 1.4); subadults 1.4 mm. (1.2, 1.5). Relative size .50.

Citellus (*Ictidomys*) *mexicanus* (Erxleben).—The bone of this species bears a very close resemblance to *tridecemlineatus*. It possesses the same laterally expanded, asymmetrical disc with the anterior emargination. The teeth on the disc are less distinct but may have been broken off in the dried specimens examined. A very small tubercle is found at the center of the indentation, on the lower side of the disc. Length (2), 2.2 mm. (1.6, 2.7). Greatest width of disc 1.1 mm. (1.0, 1.2). Relative size .43.

Citellus (*Poliocitellus*) *franklini* (Sabine).—The os clitoridis (Fig. 1,H) is a relatively simple structure. The shaft is straight, and the spoon is only moderately expanded and does not curve dorsad. The dorsal face is only shallowly concave and has a small pit near the point where the shaft joins. There are no teeth on the disc although its border is somewhat irregular and asymmetrical. A distinct projection is present at the middle of the anterior margin. Length 2.0 mm. Greatest width of disc .9 mm. A six to eight week old juvenile possesses an undeveloped bone that exhibits typical *Citellus* features. It consists of a short, slender shaft and a broad simple disc which lacks projections on the margin and has essentially flat surfaces. It is perforated by a small foramen near the point at which the shaft attaches. Ossification might occlude this opening as the animal matures. Length 1.0 mm. Greatest width of disc .6 mm.

Citellus (*Otospermophilus*) *variegatus* (Erxleben).—A dried specimen (Fig. 1,I) is a rod-like element with the distal portion only slightly enlarged and marked by a prominent dorsal sulcus. The shaft is almost straight but has a slight twist to it. It terminates as a slight swelling at the extreme distal end of the bone. Length 2.0 mm. Greatest width of terminal expansion .4 mm.

Citellus (*Notocitellus*) *adocetus* Merriam.—The cleared structure (Fig. 1,J) is cartilaginous. Of all *Citellus* examined, it resembles *leucurus* most closely. Both have a well developed disc which is symmetrical, more or less fan-shaped, and equipped with evenly spaced teeth along the margin. *Adocetus* has the disc relatively much smaller, less expanded, set at a lesser angle to the axis of the shaft, and more deeply concave on the dorsal surface. In the specimen examined 13 teeth are present on the margin of the disc. The shaft is straight with the proximal end widened in lateral view and possessing three projections at the extreme base and a fourth slightly distad. Length 3.0 mm. Greatest width of disc 1.3 mm.

Citellus (*Ammospermophilus*) *leucurus* (Merriam).—This species (Fig. 1,K) has rela-

tively the largest and best developed disc of those studied. The disc is broadly fan-shaped and is wider than the length of the shaft which joins it at a distinct angle. Its margin is very symmetrical and provided with about a dozen evenly spaced teeth and several smaller projections; it is only slightly concave above. The shaft is slender for most of its length but becomes dorso-ventrally thicker at the proximal end. Length 1.3 mm. Greatest width of disc 1.1 mm.

Citellus (*Xerospermophilus*) *tereticaudus* (Baird).—A dried example (Fig. 1,L) is suggestive of *C. franklini* but the disc is less rounded and more concave. Its margin also bears several blunt teeth. Proximally, the shaft is expanded and distally it does not project beyond the anterior margin of the disc. Length 1.4 mm. Greatest width of disc .6 mm. Relative size .47.

Citellus (*Callospermophilus*) *lateralis* (Say).—The os (Fig. 1,M) is vaguely similar to *C. variegatus* in general shape but is basically quite different. It is a rod-shaped structure in which the distal end does not enlarge into a disc but becomes flattened and curved upward. At its truncate anterior margin are a few fairly distinct teeth. A short distance proximad, the shaft bears a sharp lateral process on the right side and a blunter projection on the left. The remainder of the shaft is round in cross section and it terminates proximally with no enlargements or projections. Length 1.8 mm. Greatest width of distal portion .4 mm. Relative size .67.

Chipmunks. The os clitoridis of *Tamias* and *Eutamias* is of a distinctive type and not likely to be confused with that of any of the other genera. Wade and Gilbert (*op. cit.*) conclude that the baculum in this group resembles the *Citellus* type more than any other. Among the forms studied the only constant feature separating the eastern and western chipmunks is the presence of a crest on the dorsal side of the spoon in all specimens of the latter. The clitoris bone of *Eutamias* (*Eutamias*) *sibiricus asiaticus* (= *E. asiaticus uthensis*) has been described by Simokawa (*op. cit.*) and apparently does not closely resemble the North American forms (*Neotamias*) studied.

Tamias striatus lysteri (Richardson).—This bone (Fig. 1,N) resembles a tiny trowel in shape. The shaft is greatly compressed, considerably arched in lateral view, and terminates in a dorsally concave, teaspoon-shaped dilation. The spoon is asymmetrical; the left margin is recurrent along the side of the shaft. The latter may join the spoon at a slight angle and may be straight or slightly curved in dorsal view. Its base is often bilobed. Principal variations in adult examples are found in the degree of arching of the shaft (it is never straight as in the baculum) and in the dorsal outline, degree of concavity, and extent of the recurrent margin of the spoon. One adult bone is clearly abnormal with the shaft well developed but the spoon entirely lacking.

Three subadult specimens taken from July of the year of birth to the following June cannot be separated with certainty from adults. A juvenile example collected June 5, although completely osseus and typically shaped, can be distinguished from the older subadults and adults by its more slender shaft and narrower proximal end. Length: adults (6), 1.7 mm. (1.2–2.2); subadults (4), 1.7 mm. (1.6–1.9); unclassified 1.9 mm. Relative size .60.

Tamias striatus griseus Mearns.—Four specimens of this subspecies average larger than *lysteri* but no morphological differences can be ascertained. Length: adults (3), 2.1 mm. (1.9–2.4); subadult 2.8 mm.

Eutamias minimus (Bachman).—The shaft of the single specimen (Fig. 1,O) is bent almost U-shaped in lateral aspect and joins the asymmetrical spoon at a slight angle. The dorsal surface of the spoon is shallowly concave and is divided by a prominent crest which extends longitudinally and somewhat obliquely from close to the insertion of the shaft almost to the end of the bone. A large opening at the base of the shaft leads into a narrow canal which extends distad through the center of the shaft. Length 1.4 mm. Relative size .41.

Eutamias ruficaudus Howell.—A specimen is essentially similar to *E. minimus* and *E. umbrinus* but has a spoon with a distinctly higher crest and more flaring margins. The anterior end of the spoon is more broadly rounded and the asymmetry of the two sides more pronounced in dorsal aspect. Length 1.4 mm.

Eutamias umbrinus (Allen).—This differs from *ruficaudus* in being slightly smaller and less robust in appearance and in having a narrower and more symmetrical spoon. It agrees more with *minimus* in general configuration but its crest is relatively the least developed of the three specimens examined. Length 1.3 mm.

Tree squirrels. The clitoris bones of *Sciurus* are actually the largest of any studied, yet are apparently relatively smaller than the terrestrial types. They resemble the corresponding bacula rather closely. With the exception of *Sciurus griseus* all of the specimens of the six North American species examined are much alike, and no trenchant subgeneric distinctions are apparent. The differences noted between *S. carolinensis*, *S. deppei*, *S. variegatoides*, *S. niger*, and *S. gerrardi* are probably, at least in part, due to individual variation. The os clitoridis of *Sciurus vulgaris* seems the least modified of those studied and is more similar to the *carolinensis* type than to *griseus*. The clitoris bones of *Sciurus vulgaris coreae* and *S. vulgaris fuscoater* have been described by Simokawa (*op. cit.*) and Sierts (*op. cit.*).

The os clitoridis of *Tamiasciurus* is extremely minute, in keeping with the rudimentary penis bone. It occurs irregularly, whereas the minute baculum is apparently always present. The reduced development of the os genitale in this genus probably represents an advanced degree of specialization in which these structures are in the process of being eliminated. A similar explanation has been advanced (Ruth, 1934) to explain the irregular occurrence of the os priapi in the domestic cat, since the bone is generally well developed in the rest of the order.

Sciurus (*Neosciurus*) *carolinensis leucotis* (Gapper).—The rather stout shaft (Fig. 2,A), slightly curved from above and somewhat arched in lateral aspect, enlarges near its distal end into a broad, almost circular disc. The dorsal edge of the disc is curled to the right,

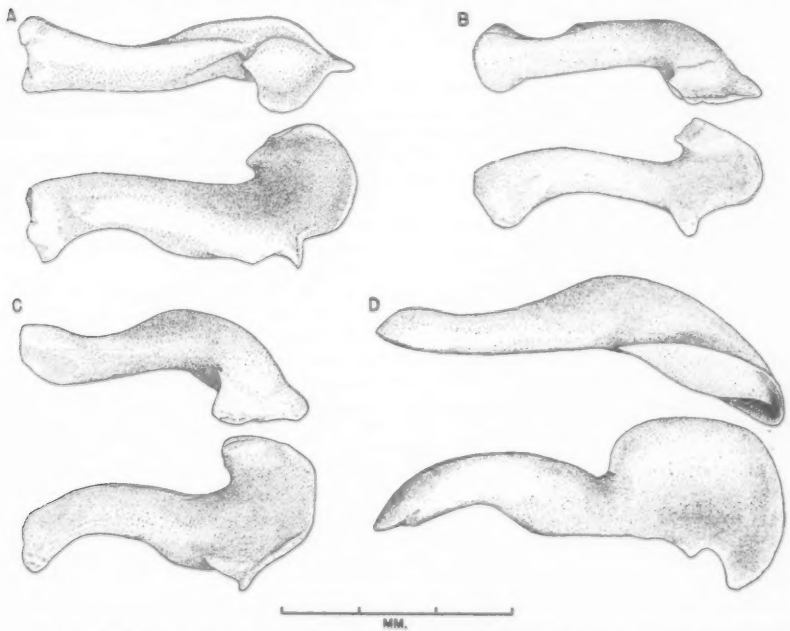

FIG. 2.—Dorsal and right lateral views of the os clitoridis of *Sciurus*. A. *Sciurus carolinensis leucotis*; B. *Sciurus niger*; C. *Sciurus gerrardi*; D. *Sciurus griseus*.

while the ventral margin bears a distinct projection. The right face is concave. The shaft is compressed with its dorsal edge sharper than the ventral. In the best developed specimens, a thick ridge originates at about the middle of the shaft at the ventral margin of the left side and curves dorsad toward the distal end where it continues across the convex left side of the disc to the anterior margin. The base of the shaft is deeply concave and has the dorsal rim distinctly cleft. Variation is noted in the thickness of the shaft, size of spoon, degree of inrolling of the dorsal edge, and development of the ventral spine. In subadult specimens the spoon is not so broadly rounded and the ventral spine seems better defined. The base of the shaft also appears less expanded but actually averages only about .1 mm. less. Length: adults (5), 3.9 mm. (3.6–4.6); subadults (4), 3.8 mm. (3.6–4.0). Width of disc: adults 1.6 mm. (1.4–1.9); subadults 1.6 mm. (1.5–1.8). Relative size .37.

Sciurus (*Neosciurus*) *deppei* Peters.—An example is essentially similar to *carolinensis* but has a relatively larger, oval-shaped disc whose dorsal rim does not curl over. The right face of the disc is also less concave and the crest on the left face less pronounced. Length 3.8 mm. Width of disc 2.1 mm.

Sciurus (*Neosciurus*) *variegatoides* Ogilby.—A specimen resembles *gerrardi* more than *carolinensis* but has a much narrower and less concave disc. There is no evidence of a crest on the left side of the shaft or disc, and the ventral projection is rather blunt. Length 3.9 mm. Width of disc 2.0 mm.

Sciurus (*Parasciurus*) *niger* Linnaeus.—A dried specimen (Fig. 2,B) is similar to *carolinensis* but has the spoon longer than wide. The ventral projection is also more tuberculate and the ridge on the left side of the disc less apparent. Length 4.0 mm. Width of disc 1.4 mm. Relative size .32.

Sciurus (*Guerlinguetus*) *gerrardi* Gray.—This species (Fig. 2,C) also resembles *carolinensis* but the single specimen examined has a relatively larger spoon, a less distinct ventral projection, and no well developed ridge on the convex surface of the disc. Length 4.2 mm. Width of disc 2.0 mm.

Sciurus (*Hesperosciurus*) *griseus* Ord.—A clitoris bone of *griseus* (Fig. 2,D) has a curved shaft which is bent laterally at about its middle. The distal end is expanded dorsally into a long blade-like crest so that the bone resembles a diminutive meat cleaver. On the ventral aspect are two rounded protuberances, a large one distally and a smaller one proximal to it. Both faces of the blade are more or less convex. Length 5.4 mm. Blade width 2.2 mm. Relative size .33.

Tamiasciurus hudsonicus (Erxleben).—The rudimentary os clitoridis of this species has previously been noted (Layne, *op. cit.*). An additional specimen from Wyoming also possesses the minute ossicle. Diameter .08 mm. Relative size .31.

Flying squirrels. The clitoris bones in *Glaucomys* are relatively the smallest of any of the forms discussed. They exhibit considerable individual variation and also show the least resemblance to the corresponding bacula. The bones of the two species, *G. volans* and *G. sabrinus*, are quite dissimilar. The bacula show these differences even more markedly.

Glaucomys v. volans (Linnaeus).—The best developed example (Fig. 1,P) is essentially a rod-shaped structure whose base extends as a hook-like projection ventrad and dextrally laterad at about a 45 degree angle from the main axis of the bone. From above, the main part of the shaft is very slightly curved and from the side is somewhat arched. It is strongly depressed and narrows in width about one third of its length from the tip, expanding again slightly at the very end. The left side is smoothly rounded but the right is extended into a prominent wing-like crest that follows the lateral margin of the shaft distad, becoming less pronounced near the end. Four specimens show considerable variation but all exhibit a somewhat basic similarity of pattern. Length: adult 2.7 mm.; subadult 1.7 mm.; unclassified (2), 1.5 mm. (1.3, 1.7). Relative size .22.

Glaucomys sabrinus macrotis (Mearns).—In dorsal view the bone (Fig. 1,Q) is rather steeply triangular with the left side strongly curved and the right side smoothly indented from the base to about the middle. Ventrally, the left edge is thickened to form a ridge which follows the margin of the bone. Two subadults are more rudimentary in shape and less

robust. Both have only faint indentations. Two other examples have only slight emarginations and more distinct ventral ridges. The small distal projection on the specimen figured was not present on other examples. Length: adults (2), 1.5 mm. (1.4, 1.6); subadults (2), 1.4 mm. (1.1, 1.7); unclassified 1.9 mm. Relative size .28.

SUMMARY

The os clitoridis has been found to occur in all forms (8 genera and 28 species) of the North American Sciuridae examined. Although usually ossified, the structure may be cartilaginous in occasional individuals, while still retaining its typical shape and size. With the exception of the red squirrel, *Tamiasciurus*, it apparently is invariably present in every individual and has a fairly constant configuration, if allowance is made for individual and age variation which may be greater in some species than in others. This relative constancy of occurrence and shape of the os clitoridis in the squirrels is in contrast to that noted in such forms as *Procyon* (Rinker, *op. cit.*), *Lutra* (Scheffer, 1939), *Callorhinus* (Scheffer, 1949) and *Urocyon* (personal observation) where it may be well developed in some females and rudimentary or completely lacking in others, often without regard to age of the individual. The extent of occurrence and relative development of the bone in other families remains to be studied.

Except in *Tamiasciurus* and *Glaucomys* the clitoris bones show the same generic features as the penis bones, and in *Marmota*, *Tamias*, *Eutamias*, *Sciurus*, and some species of *Citellus* they exhibit a fairly close correspondence in general configuration to the respective bacula. In most cases the clitoris bones themselves seem to be distinctive for the species, but where only one or two specimens was examined the apparently diagnostic features noted must be regarded as tentative since the degree of variation is not known. In some cases subgenera appear to possess a characteristic os clitoridis.

The size of the os clitoridis is roughly proportional to the size of the baculum, but there seems to be no correlation between the size of the animal and the relative development of either the clitoris or penis bone. Disparity in the relative size of the clitoris bone as compared to the baculum is noted, and in the present series the os clitoridis is relatively the smallest in the arboreal squirrels.

With respect to taxonomic use, mean differences in measurements of the bones may be useful accessory data in the study of specific and infraspecific units, but morphological differences are likely to be more trenchant in the baculum. In the higher categories, such as in a comparison of two genera or families, a knowledge of the distribution and degree of development of this bone may be useful in estimating relative phylogenetic status. For example, it would probably be considered a more primitive or less specialized condition when the clitoris bone occurs widely in the species comprising a group and in every individual, is relatively large as compared to the baculum, and has a fairly constant configuration than when the bone occurs only sporadically and shows great variability.

The bones would probably have little practical application as an age criterion in Sciuridae, even though age differences can be demonstrated, since they are difficult to prepare and examine and differences between age groups are often qualitative or represented by mean measurements. It also appears that the bones

assume adult proportions and configuration at a time when age classes can still be discerned by external or more accessible internal features.

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NON-GEOGRAPHIC VARIATION IN CRANIAL MEASUREMENTS OF WILD-TAKEN *PEROMYSCUS LEUCOPUS NOVEBORACENSIS*

By E. Lendell Cockrum

The wood mouse, *Peromyscus leucopus*, is found primarily in woods and brush. In Kansas this species is widely distributed in the eastern, wooded part of the state; in the central and western parts, however, it is restricted to the wooded and brushy valleys of streams. The major drainage pattern, in Kansas, is from west to east. Trees and shrubs extend westward across the state, along the various stream courses. As a result, a detailed map of the distribution of *Peromyscus leucopus*, in central and western Kansas, would be dendritic, matching, almost perfectly, the patterns of the streams and their main tributaries.

The following statistical analysis of non-geographic variation (that is, variation resulting from age, individual, or secondary sexual differences) in the cranial measurements usually taken of skulls of *Peromyscus*, was undertaken with two specific purposes in mind: (1) to find which measurements show the least individual variation, and (2) to find if all individuals with at least some wear on the teeth, of either or both sexes, show enough homogeneity to be combined in a sample for the purpose of comparing the various populations of *P. leucopus*.

Procedure.—One hundred and seventy-two specimens of *Peromyscus leucopus noveboracensis* from Douglas County, Kansas, in the University of Kansas Museum of Natural History, form the basis of this study. These specimens were separated into two groups according to sex, and, for each sex into six "age-groups," as defined below. Cranial measurements, also defined below, were taken with a dial caliper and the aid of a low-powered binocular dissecting microscope.

Since I know of no method of determining the actual age of unmarked, wild-taken specimens of *Peromyscus*, I divided the specimens used in the present study into six "age-groups," each based primarily upon the degree of wear of the teeth. Obviously tooth-wear is a continuous process that probably varies in rate both with hereditary factors and with individual and local differences in diet and such "age-groups" are, at best, approximations. These six "age-groups" are characterized as follows:

1. Third upper molar erupted but not reaching height of first and second upper molars; skin in juvenal pelage.
2. Third upper molar at full height in tooth row; little or no wear on any cheek teeth; skin in juvenal pelage, or, in a few specimens, molting into adult pelage. Two individuals placed in this group on the basis of tooth wear had adult pelage.
3. At least some wear on last upper molar. All but one individual in this class in adult pelage; molt into adult pelage approximately two-thirds complete in the exception.
4. At least some wear on all upper molars; adult pelage.
5. Heavy wear on all upper molars; many cusps obliterated by wear.
6. Extreme wear on all upper molars; all cusps obliterated by wear.

The distribution by sex and "age-group" of the 172 specimens is shown in Table 1. Certain cranial measurements could not be taken on some skulls be-

TABLE 1.—*Distribution, by sex and "age-group" of the 172 individuals of Peromyscus leucopus noveboracensis for Douglas County, Kansas, used in the present study*

"AGE-GROUP"	1	2	3	4	5	6	TOTAL
Males	2	11	11	35	26	14	99
Females	8	4	14	23	16	8	73
Totals	10	15	25	58	42	22	172

cause many were more or less broken or disarticulated. Sufficient undamaged specimens in the two younger "age-groups" (1 and 2) were not available to warrant analysis.

MEASUREMENTS

A cursory inspection of the literature reveals that the cranial measurements of mammals taken for purposes of comparisons of various samples differ greatly from group to group. For example, a set of cranial measurements taken on skulls of shrews is almost entirely different from that taken on skulls of carnivores, as is shown by the measurements given by Jackson (1928) for long-tailed shrews and those given by Goldman (1944) for wolves. Since cranial measurements are usually taken not to show similarities between two or more samples but rather to show and emphasize differences between samples (that is, the diagnostic characters), the differences in kinds of measurements taken is not surprising. Within a given group there is considerable uniformity in the cranial measurements ordinarily made. However, even here, the cranial measurements used vary from worker to worker and even from time to time by the same worker.

Cranial measurements employed by Dice (1932, 1937, 1939), Fox (1948), Hall (1946), and Osgood (1909), on mice of the genus *Peromyscus*, as well as certain other measurements, were used. The measurements used, and the points between which they were taken, are as follows:

Skull length: "from left condyle to most anterior part of left premaxilla. The point on the premaxilla taken is slightly below the nasal and is not in the median line of the skull." (Dice, 1937: 6). This measurement is probably the same as the "condyle-premaxillae" length used by Fox (1948: 429).

Greatest length of skull: "the length over all from the tip of the nasals to the posterior bulge of the brain case." (Osgood, 1909: 22).

Condylobasilar length: distance, in the midline of the skull, from a line connecting the posteriomost margins of the upper incisors to a line connecting the posteriormost margins of the condyles. "Condylebasilar" length: "from the posterior margin of the occipital condyle to the base of the incisor at its posterior margin." (Fox, 1948: 421).

Basilar length: "distance on skull from the anteriormost inferior border of the foramen magnum to a line connecting the posteriormost margins of the alveoli of the first upper incisors." (Hall, 1946: 674).

Condylo-zygomatic distance: "from the left condyle to angle at most anterior part of zygomatic process of the left maxilla." (Dice, 1932: 7).

Greatest breadth of braincase: greatest distance across the braincase immediately posterior to the zygomatic arches.

Mastoid breadth of skull: "width of skull across mastoid processes." (Dice, 1932: 7).

Zygomatic width: "the greatest distance between the outer sides of the zygomata." (Osgood, 1909: 22). This is probably the same as the "zygomatic breadth" of Dice (1939: 2) which he defined as: "greatest width of skull across the zygomatic processes of the temporal bones."

Interorbital constriction: "the width of the most constricted part of the interorbital space." (Osgood, 1909: 22). "The least distance across the top of the skull between the orbits (eye sockets)." (Hall, 1946: 678).

Length of nasals: "the greatest length along the suture between the nasals" (Osgood, 1909: 22), and "from the most anterior part of either nasal to the most posterior extension of that nasal in the median line of the skull." (Dice, 1939: 2). For all practical purposes, these two methods result in the same measurement in all but a few specimens. The measurements presented here were taken by the method described by Dice.

Interparietal: "the greatest length and width." (Osgood, 1909: 22).

Parietal width: The greatest width of the parietals.

Parietal length: The greatest length, measured along the suture in the midline of the skull.

Frontal length: the greatest length, measured along the suture in the midline of the skull.

Frontal width: the greatest anterior width of the frontals, measured across the zygomatic extensions immediately posterior to the nasals.

Shelf of bony palate: "the distance from the posterior ends of the anterior palatine foramina to the anterior border of the interpterygoid fossa." (Osgood, 1909: 22).

Palatine slits: "the greatest length of the anterior palatine foramina." (Osgood, 1909: 22).

Diastema: "from the posterior margin of the alveolus of the incisor to the anterior margin of the alveolus of the first cheek tooth." (Fox, 1948: 421). "Anterior base of upper molars to posterior base of incisors." (Osgood, 1909: 22).

Postpalatal length: "the distance from the anterior border of the interpterygoid fossa to the inferior lip of the foramen magnum." (Osgood, 1909: 23).

Maxillary tooth-row: "the alveolar length of the three upper molariform teeth." (Osgood, 1909: 23).

Length of mandible: "greatest length of left mandible, from condyle to end of incisors." (Dice, 1932: 6).

VARIABILITY OF MEASUREMENTS

The coefficient of variation (V) was computed for each age group of each sex for the 22 cranial measurements studied. In Table 2 the arithmetic mean and the range of the coefficients of variation are given for each of the cranial measurements. The cranial measurements are arranged in the order of the increasing value of the means of their coefficient of variation.

Measurements with a low coefficient of variation do not necessarily vary geographically, or with age or sex, and, conversely, measurements with a high coefficient of variation may show such variations. In the latter case variations may be obscured and difficult to demonstrate statistically. At least for the species and area concerned the following measurements are too highly variable to show significant geographical variation as shown by the values of the coefficients of variation (averaging more than 4.0): diastema, post-palatal length, palatine slits, frontal width, shelf of bony palate, frontal length, interparietal width, parietal length, and interparietal length. The usefulness of the following measurements (with values of the coefficients of variation between 3.10 and 4.00) is questionable: length of mandible, alveolar length of maxillary tooth-row, greatest breadth of brain case, least interorbital constriction, and length of nasals. The remaining measurements, mastoid breadth, greatest length of skull, condylobasilar length, basilar length, skull length, and parietal width, show relatively little individual variation (the values of the coefficients of variations average less than 3.10).

Fox (1948: 421) found measurements of the frontals, parietals, interorbital breadth, and tooth-row to be too variable to establish the presence or absence of significant differences between population samples of *Peromyscus maniculatus*

TABLE 2.—*The arithmetic mean and the range of the coefficients of variation for each of the cranial measurements taken on a series of Peromyscus leucopus noveboracensis. The cranial measurements are arranged in the order of the increasing value of the means. The columns to the right indicate where significant differences occur between the various "age-groups"*

CRANIAL MEASUREMENTS	COEFFICIENT OF VARIATION		SIGNIFICANT DIFFERENCE BETWEEN "AGE-GROUPS"*					
	Average	Range	3–4	3–5	3–6	4–5	4–6	5–6
Mastoid breadth	2.31	(1.51– 3.19)	0	0	0	1	1	0
Greatest length of skull	2.49	(1.64– 3.71)	0	2	3	2	3	2
Condylo-zygomatic distance	2.51	(1.61– 3.63)	0	3	3	2	3	0
Zygomatic breadth	2.55	(1.41– 4.03)	0	1	3	0	1	1
Condylobasilar length	2.63	(1.56– 3.55)	0	3	3	0	3	0
Basilar length	2.82	(1.95– 3.59)	0	3	3	3	3	0
Skull length	2.91	(1.73– 4.50)	0	3	3	2	3	2
Parietal width	3.05	(1.60– 3.96)	0	0	0	0	0	0
Length of mandible	3.10	(2.32– 4.59)	2	3	3	0	3	0
Alveolar length of maxillary tooth row	3.49	(2.44– 4.40)	0	0	0	0	0	0
Greatest breadth of brain case	3.59	(2.82– 4.99)	0	0	0	0	0	0
Least interorbital constriction	3.76	(2.56– 4.49)	0	2	1	0	1	0
Length of nasals	3.81	(2.15– 5.12)	0	1	3	1	3	1
Diastema	4.21	(2.46– 7.80)	1	3	1	3	1	1
Postpalatal length	4.36	(3.48– 6.64)	0	0	3	0	3	1
Palatine slits	5.18	(4.21– 6.84)	0	1	1	1	1	0
Frontal width	5.60	(3.61–12.63)	0	0	0	0	0	0
Shelf of bony palate	6.17	(4.14– 9.31)	0	0	0	0	0	0
Frontal length	6.26	(4.61– 9.64)	0	0	0	0	0	0
Interparietal width	6.53	(5.35– 9.32)	0	0	0	0	0	0
Parietal length	8.27	(5.73–10.64)	0	0	0	0	0	0
Interparietal length	11.76	(8.57–16.11)	0	0	0	0	0	0

* 0 indicates no significant difference between age groups in either sex; 1 indicates a significant difference between age groups only in females; 2, males; and 3, between age groups in both males and females.

TABLE 3.—*The arithmetic means and ranges of the coefficients of variation of several cranial measurements of Peromyscus leucopus from Douglas County, Kansas, and of Peromyscus maniculatus from several localities in the lower Columbia River Valley*

	PEROMYSCUS LEUCOPUS	PEROMYSCUS MANICULATUS
Mastoid breadth (= bullar width of Fox?)	2.31 (1.51–3.19)	2.48 (1.83–4.16)
Condylozygomatic distance	2.51 (1.61–3.63)	2.52 (1.47–3.49)
Zygomatic breadth	2.55 (1.41–4.03)	2.99 (2.03–4.63)
Condylobasilar length	2.63 (1.56–3.55)	2.57 (1.22–3.88)
Skull length (= condylopremaxillae of Fox)	2.91 (1.73–4.50)	2.49 (1.07–3.70)
Length of mandible	3.10 (2.32–4.59)	2.70 (1.35–4.65)
Alveolar length of maxillary tooth row	3.49 (2.44–4.40)	*
Least interorbital constriction	3.76 (2.56–4.49)	*
Length of nasals	3.81 (2.15–5.12)	4.01 (2.92–5.30)
Diastema	4.21 (2.46–7.80)	3.83 (2.03–7.11)
Frontal length	6.26 (4.61–9.64)	*
Parietal length	8.27 (5.73–10.64)	*

* "... too highly variable in a given population to establish significant differences ...." (Fox, 1948: 421).

from along the lower Columbia River, in Washington and Oregon. Table 3 shows the arithmetic mean and range of the coefficients of variation of several cranial measurements of *Peromyscus leucopus* from Douglas County, Kansas, and of *Peromyscus maniculatus* from the lower Columbia River valley. The latter values were computed from the coefficients of variation given by Fox (1948: 447–451) for samples from 16 different localities. Considering the fact that two different species from localities separated by approximately 1500 miles are being compared, the results are remarkably similar. Additional data of this sort might show that the coefficients of variation of a given measurement are approximately the same for various populations throughout the range of the genus.

SAMPLE VARIATION

As is usually the case, the sample from Douglas County is neither as homogeneous nor as large as desirable. Ideally, of course, the sample should be taken simultaneously and in a continuous, geographically restricted habitat (a single population), and for statistical significance of a higher level of probability, should contain a minimum of 30 measurable skulls in each sex-"age-group" class. Actually, however, the specimens were collected over an extended period of years (1894 to 1946) at several localities (all, however, within a radius of ten miles of Lawrence, Douglas County, Kansas), and, as is shown in Table 1, only one sex-"age-group" class contains 30 or more skulls.

SECONDARY SEXUAL VARIATION

The method proposed by Dice and Leraas (1936) was used to test differences between the sexes. Significant secondary sexual differences were found, in this series of measurements, only between the means of the measurements of the mastoid breadth of individuals in "age-group" 5. In all other measurements taken, no significant differences exist between the means of the two sexes, when individuals of the same "age-group" are compared.

AGE VARIATION

The problem of securing comparatively homogeneous subsamples by dividing the individuals of a series into groups of similar age has long plagued mammalogists. Some workers have avoided the problem by using laboratory-raised specimens of known age (see Dice, 1932, 1937, and elsewhere; and others). At least theoretical objections can be made to this procedure on the grounds that, because of the influences of captivity, the results do not reflect what happens to the species in nature. Other workers, using wild-taken specimens of unknown age, have attempted to secure more homogeneous subsamples by using morphological age characters such as the degree of wear showing on the teeth or the growth rings on horns of animals such as the males of mountain sheep (Cowan, 1940; Dalquest and Hoffmeister, 1948; and others). Similar objections can be made to this procedure on the grounds that, since actual age is unknown, individual variations cannot be adequately separated from age variations of morphological characters.

Hall (1926) has correlated morphology with age in a study of the California ground squirrel, *Citellus beecheyi*. He used embryos, young of known age, a graded series of individuals less than one year in age, and a small group of individuals more than one year in age. Hoffmeister (1951), in his excellent study of the piñon mouse, *Peromyscus truei*, divided the wild-taken series available to him into five age groups. Hoffmeister correlated the morphological characters of laboratory-raised specimens of known age with those of the wild-taken series. Unfortunately the oldest mice of known age were but 75 days old. Morphologically these mice were judged as intermediate between age group 1 and 2 of the wild-taken specimens.

Gentile (1952) described "the variation found in the skulls of the Norway rat, *Rattus norvegicus* (Berkenhout) from a segment of Baltimore, Maryland." He divided the wild-taken rats into three "size groups", basing his divisions on "arbitrary criteria" incorporating tooth wear, cranial proportions, and ridging of skull. Gentile found significant differences existing between all three size-groups in nine of the ten cranial measurements taken.

Miller (1952) described size characteristics of a pocket gopher (using weights and external measurements only), basing his description on a total of nearly 2300 specimens from a restricted area in California. He found "Frequency distributions for weights, length, and other size characteristics are sometimes composites of several more or less widely overlapping but statistically distinct categories in the population such as juvenile, subadult, and adult males; or virgin, pregnant, recently-parous, and parous females."

To my knowledge, no attempts have been made to correlate morphological age characters of *Peromyscus* with actual age, throughout their life span, either by using specimens raised in the laboratory or by using specimens marked at birth, released, and recaptured at a later time. Even if based on laboratory-raised animals such studies would aid in interpreting the mass of data available from specimens regardless of theoretical objections which may be raised because of the influence of captivity.

The method proposed by Dice and Leraas (1936) was used to test differences between the "age-groups" of the *Peromyscus leucopus* from Douglas County, Kansas, examined in the present study. Table 2 shows where significant differences were found. As expected, significant differences were not demonstrable in those measurements that show large individual variations (as evidenced by a large value for the coefficient of variation). The parietal width, with a relatively low coefficient of variation, did not show any significant age variation.

Dice (1932) described the age variation of *Peromyscus maniculatus bairdii* of known age, all raised in captivity. He found (*op. cit.*: 13–14) that: "Although these mice may be sexually mature at an age of three months or less, and although adult pelage is acquired at ages well under a year, the mouse continues to grow in size until he is at least somewhat over one and one-half years old." This discovery led Dice to conclude that: "Series of animals taken in the field cannot be used for statistical comparisons unless some fairly accurate means of determining their age can be found." Dice (1937: 7), in a later study made on a series of laboratory-raised *Peromyscus leucopus noveboracensis*, found that: "A

comparision between the body measurements of the 2-year old and 1-year old mice . . . fails to disclose any important differences correlated with age."

Howard (1949: 17), found from observations of marked *Peromyscus maniculatus bairdii* in southern Michigan that in nature: Females that are born between late March and mid-May usually breed at the age of four and one-half to nine weeks. Females born after mid-May usually do not breed until September. Females born before the middle of September usually breed in October, and, if not born until late September or October, do not breed until the following spring when they are 24 to 27 weeks of age or older. From Howard's findings it is evident that sexual maturity cannot be used as a criterion of actual age of wild-taken specimens of *Peromyscus*.

The question now arises—how long does a *Peromyscus* live in nature? Blair (1948: 410–411) stated that: "Mice of the genus *Peromyscus* ordinarily live to an age in excess of three years in captivity." Dice (1933: 147) reported some individuals of this genus that lived in captivity to ages of seven and eight years. Blair (1948) thought that the length of time that a mouse remained on a trap plot, where a systematic program of live trapping and marking was being carried on, permitted a crude estimate of the life span of an individual in nature. He found (*op. cit.*: 339): "The average length of time that a deer-mouse [*Peromyscus maniculatus bairdii*] was on the plot, as estimated for 104 mice by this method, was 4.88 ± .20 months. The shortest stay . . . was 2.5 months, and the longest 12.5 months." For the wood mouse (*Peromyscus leucopus noveboracensis*) the average was somewhat less, 4.23 ± .22 months. Blair concluded (*op. cit.*: 411) that the actual life span in nature, as indicated by his data, "is much shorter than the potential life span, and it is probably rare indeed that an individual lives out its potential life span in nature."

In a period of two years, Howard (1949), using nest boxes buried in the ground, and live traps, marked more than 1200 prairie deer mice (*Peromyscus maniculatus bairdii*) in southern Michigan. He found only eight mice that were known to have lived in the study area for more than 73 weeks: four males lived at least 104, 83, 76, and 74 weeks, and four females lived at least 78, 77, 76, and 76 weeks. He concluded (*op. cit.*: 39) that: "It is doubtful that any prairie deermice reach old age senility, since the oldest animals which were observed were one and one-half to two years in age, and they apparently had remained fully fertile. Less than one-fifth of the deermice reached sexual maturity."

Dice (1933: 147) described the evidence of senility in laboratory raised *Peromyscus maniculatus* as follows: "In the old mice in general there was a stiffness in movements and a lack of vigor; the body was lean, sometimes almost emaciated; the pelage seemed to be thin; and the color was paler than normal for animals in their prime, but was never entirely white." In no one of the 172 study skins of *Peromyscus leucopus noveboracensis* from Douglas County, examined in the present study, did I find any indication of thinness of pelage or paler coloration due to old age, a fact that lends support to Blair's (1948) and Howard's (1949) conclusion that the actual life span in nature is shorter than the potential life span.

Collins (1918: 78) found, from observations on several Californian subspecies

of deer mice, *Peromyscus maniculatus*, kept in the laboratory, that: "The transition from the juvenal to the post juvenal pelage usually begins at the age of six weeks and is completed about eight weeks later." If these data from observations on laboratory-raised animals can safely be applied to wild-taken animals of a different species, then the specimens of *Peromyscus leucopus* in "age-groups" 1 and 2, as defined above, are probably less than four months of age.

From the above considerations I have concluded that the "age-groups" are real and represent groups of individuals of comparable age. Further, by utilizing such "age-groups," I suggest that series of wild-taken animals can be used for statistical comparisons. Without such groupings, however, age variations between samples may be great enough to obscure differences resulting from other causes.

Fox (1948: 423), in working with samples of *Peromyscus maniculatus* from the lower Columbia River valley, thought that: "Age variation did not appear to be significant in specimens that no longer showed juvenal pelage and which show at least a slight wearing on the last molar. Only those of this type or older were used in the samples. The younger of the *Peromyscus* falling within this age limit seem for the most part to have attained full adult proportions." The samples available to Fox, from 17 different localities, varied in size from six to 36 individuals. Obviously, even the largest sample, containing 36 individuals, was not large enough to permit a reliable statistical analysis of non-geographic variation of the population, a necessary prerequisite for determining geographical variation. Differences between the means of cranial measurements of "age-group" 3 and "age-group" 6 of the *Peromyscus leucopus* from Douglas County, approach, in value, the differences between the means of the same cranial measurements of the different population samples used by Fox. In other words, age variation of the individuals examined in the present study are almost as great as some (and greater than most) of the variations between populations, ascribed by Fox to geographic variation. This fact, while not disproving his conclusions, at least casts some doubt upon them. Assume, for example, that 50 per cent or more of Fox's "Oak Slough" population sample (with 8 to 10 measurable skulls), which shows a significantly lower mean in most measurements, are of "age-group" 3 and the rest are of "age-group" 4. Further, assume that 50 per cent or more of the Wahkiakum population sample (with 7 to 8 measurable skulls) which shows a significantly higher mean in most measurements, are in "age-group" 6 and that the remainder are in "age-group" 5. Then at least a large percentage of the difference between the means of these two samples might be due to age variation. Perhaps these assumptions are not unlikely since the proportion of young to old individuals in a given population varies markedly with the season. Howard (1949) found in a population in southern Michigan that in December (when the "Oak Slough" sample was taken (Fox, 1948: 421)) 50 per cent or more of the individuals were born in the fall of that year and 75 to 90 per cent were individuals born since the preceeding spring. The population in spring and early summer contained a high percentage of overwintering adults and a low percentage of young of the year. (The Wahkiakum sample was taken sometime between May

and August, exact date not given. (Fox, 1948: 421)) Perhaps the populations of deer mice in the lower Columbia River Valley do not show the same pattern of seasonal fluctuation of population structure as found by Howard in southern Michigan. Undoubtedly, however, seasonal variations do occur in the lower Columbia River Valley, thus influencing the proportion of young-old individuals taken in a trap line at a given time.

SUMMARY

A statistical analysis was made of the non-geographic variation shown in 21 cranial measurements of 152 wild-taken specimens of *Peromyscus leucopus noveboracensis*, all from within a radius of ten miles of Lawrence, Douglas County, Kansas. Certain cranial measurements were found to show little individual variation while others were so highly variable that their usefulness for purposes of analyzing geographic variation in *Peromyscus* is considered to be questionable. Secondary sexual differences are not demonstratable in most of the cranial measurements taken. Age variations, however, are evident in most cranial measurements of low individual variability, and, in value, approach or exceed values ascribed by Fox (1948) to geographic variation in *Peromyscus maniculatus* in the lower Columbia River Valley.

Acknowledgments.—Grateful acknowledgement is made to Dr. E. Raymond Hall, Director, Museum of Natural History, University of Kansas, Lawrence, who not only made available the specimens studied but also gave much helpful advice.

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GROWTH AND THE DEVELOPMENT OF TEMPERATURE REGULATION IN THE TUNDRA REDBACK VOLE

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The redback vole is a representative Alaskan species that ranges over much of the territory and is often found in large numbers. It meets successfully whatever extremes are imposed upon it by the rigorous northern environment. These include not only the low winter temperatures but also the shorter summer season during which food is more abundant and the temperature is ameliorated. Since the growth and development of the young may take place largely during this shorter season one might look for a high growth rate in the nesting mice or an early attainment of the ability to regulate temperature. Both of these factors will influence the age at which the young mouse can leave the nest to live a free, independent life with its subsequent growth no longer limited by the maternal food supply.

Materials and methods.—The tundra redback vole, *Clethrionomys rutilus dawsoni*, (Rausch, 1950) was by far the most abundant mammal in central Alaska as evidenced by two months of fairly intensive summer trapping in 1950 (Strecker, *et al.*, 1952). Not only were these animals obtained at all trapping stations except in the extreme north and in areas above timber line, but they were captured in a variety of habitats including spruce woods, low wet areas, drier uplands and birch woods. In wooded areas they were either common or abundant, often showing a trapping return of more than 30 per cent per trap day.

Observations were made on six litters of mice that were born in captivity between July 15 and 23 following capture of pregnant females. All individuals were weighed at one- or two-day intervals during the first 20 days. Normal body temperatures, i.e., nesting temperatures, were measured during the first five weeks of life and the resistance of the young animals to cold was followed up to the 22nd day. Some observations on three litters of the collared lemming, *Dicrostonyx rubricatus rubricatus*, and on a single litter of the tundra vole, *Mi-*

crotus oeconomus macfarlani, are also presented. The capture of the wild-born litter of lemmings is described by Strecker and Morrison (1952). The other two lemming litters were born in captivity in Madison following controlled breeding of a male from Nome and a female from Barter Island. The gestation periods were 21 and 22 days respectively.

Body temperatures were measured with a Leeds and Northrup recording potentiometer using iron-constantan thermocouples and following, in general, procedures developed for adult mice (Morrison and Ryser, 1951, 1954). This instrument had a 0–50°C. range, and was sensitive to 0.1° and accurate within 0.2° when calibrated against mecurial thermometers or melting ice. Thermocouples of 30 ga. wire were used for the smallest animals, which weighed as little as 5 g. in the early measurements. Insertions in these small animals were only to a depth of 10–15 mm. but as they approached adult size the depth was increased to 25–35 mm. and 22 ga. couples were used. Measurements on nesting mice were made immediately after removal from the nest. Temperatures were recorded at 32-second intervals for several minutes and the values extrapolated back to the moment at which the animal was first disturbed, usually only 30–60 seconds before the first recorded point. The young animals were exposed to cold during confinement in No. 2 cans with a light cardboard floor, which were immersed in a temperature-regulated, water bath. Mild ambient temperatures and short exposure times were used with the younger animals, but as the capacity for regulation developed these conditions were intensified to a temperature of 0° for several hours.

These studies were carried out at the Arctic Aeromedical Laboratory and were supported in part by contract between the University of Wisconsin and the Alaskan Air Command, Arctic Aeromedical Laboratory, Ladd Air Force Base, Fairbanks, Alaska and by research grant from the Wisconsin Alumni Research Foundation.

RESULTS AND DISCUSSION

Growth.—At birth the young *Clethrionomys* were completely bare although the dorsal surface was gray-pink and a faint indication of the vibrissae could be seen. The vibrissae were clearly seen at 2 days and were prominent at 5 days. During the first 3 days the gray cast of the back became darker and hair was seen at 3–4 days. This dorsal hair appeared quite reddish by 7 days. Hair did not appear ventrally until 5–6 days, but by 6–7 days the belly was covered by a sparse, creamy layer through which the mammae were clearly visible. The external ear was open at 3–4 days but the auditory canal did not open until 8–9 days. The incisors were quite plain at 9 days and the eyes opened at 10–11 days. The young showed progressively greater movement and could be described as very active at 9 days. Observations on the single litter of *Microtus* were quite comparable, indicating a slightly faster development. At 6–8 days the young were well furred above, but thinly below and the external ears were open. By 9 days, the incisors were well through and the eyes open in one, although the auditory canal was still closed, and the mammae were visible on the under side.

Average litter weights by days for *Clethrionomys* are tabulated in Table 1,

TABLE 1.—*The body weight in growing redback mice as a function of age*

AGE IN DAYS	LITTER NUMBER AND SIZE					
	#19	#23	#25	#31	#32†	#33
	7 → 5	6→5	5	7→4	6→5	8→4
0	(1.65)*	(1.65)	(1.70)	(1.95)	(1.55)	(1.8)
1	2.04†	2.20	(2.27)	(2.38)	2.03	2.70
2	(2.55)	2.63	2.84	2.81	(2.57)	(2.99)
3	3.08	3.28	3.44	(3.06)	3.12	3.28
4	3.58	(3.80)	(4.03)	3.31	(3.56)	(3.76)
5	4.18	4.32	4.62	(3.72)	4.00	4.24
6	(4.68)	(4.71)	5.20	4.13	(4.35)	(4.81)
7	5.17	5.11	5.58	(4.78)	4.70	(5.39)
8	(5.56)	(5.45)	(6.10)	(5.43)	(5.19)	(5.96)
9	5.95	5.78	6.62	(6.08)	(5.58)	6.54
10	(6.54)	(6.19)	6.91	6.73	(6.07)	(6.67)
11	7.13	(6.60)	7.20	(7.19)	6.65	6.80
12	(7.43)	(7.01)	(7.94)	7.66	6.97	7.24
13	(7.77)	7.42	8.68	8.15	(7.33)	(8.26)
14	(8.01)	8.46	(9.50)	8.80	7.68	9.28
15	8.32	9.46	(10.33)	(9.39)	8.23	
16	8.48	10.02	(11.15)	9.98	(8.86)	
17	9.12		11.98		9.50	
18	9.9					
19			12.40			
20						
21						16.05
23				12.95		
24					15.88	
26		16.36				
28	17.70					
30			15.76			
31						

* Parenthesized values were interpolated for use in calculating overall average values.
† Litter runt omitted from averages, grew much more slowly and died on 18th day.

and growth curves for the slowest and fastest growing litters are plotted in Figure 1, A. In the upper curve, individual points are shown to indicate the variability. This was next to the greatest in this particular litter. Data for litters of *Dicrostonyx* and *Microtus* are tabulated in Table 2 together with average values for the three species. In all these litters, growth during the first twenty days was closely described by a simple, straight line. Accordingly, growth during this period can be represented by a simple, linear constant. These linear growth constants for the various litters are summarized in Table 3. The correspondence between mean, individual growth rates in the several litters is fairly good, but a definite trend towards slower growth in the larger litters of *Clethrionomys* can be seen. The summed, litter growth rates are more constant than the average values for individuals in a litter. This suggests that the early growth rate may not be an inherent attribute of the young individual but is, rather, dependent

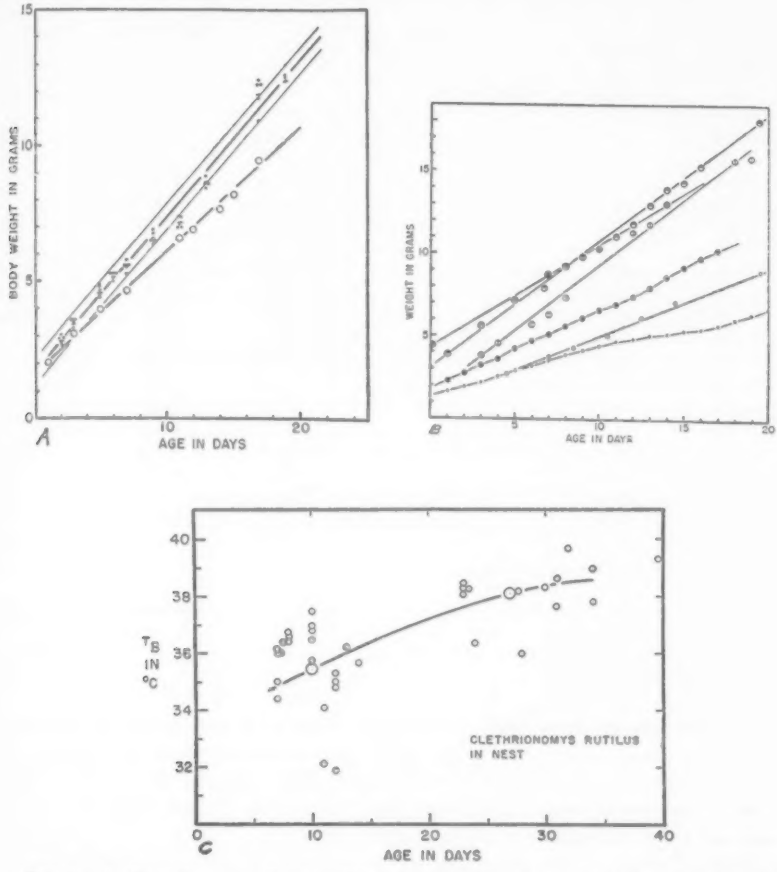

FIG. 1.—A: Growth curves for two litters of redback mice representing the observed range. Upper curve, individual values (litter #25); bar shows average; heavy curve represents best fit by inspection; light curves show Sy, the standard error of estimate. Note that this litter showed next to the greatest variability (Table 2). Open circles, average values for litter #32.

B: Average growth curves for Alaskan and "temperate" species. Half circles, collared lemming; crossed circles, California mouse (McCabe and Blanchard, 1950); lined circles, tundra vole; solid circles, redback tundra vole; open circles, deer mouse (Ryser and Morrison, 1953); points, white mouse (Parkes, 1926).

C: The relation between body temperature in the nest and age in *Clethrionomys*. 37 measments on 22 young from 8 litters. Significance: 7–14 vs. 23–34 days; $t = 5.57$, $p = < .0001$.

TABLE 2.—*The body weight in growing lemmings and mice as a function of age*

AGE IN DAYS	DICROSTONYX				CLETHRIONOMYS	MICROTUS
	♯1	♯2	♯3	3 litters	6 litters	1 litter
	4→2*	2→1*	3*			4→2*
0			(3.1)	3.1	(1.71)	
1		3.6	4.2	4.0	2.25	
2		—	—	—	2.73	
3		—	5.6	5.8	3.21	3.8
4		—	—	—	3.67	4.5
5		—	7.2	7.7	4.18	—
6	7.4	9.4	—	7.8	4.65	5.7
7	8.4	—	—	8.7	5.12	6.3
8	9.5	—	9.4	9.6	5.62	7.3
9	10.4	10.4		10.5	6.09	—
10	11.2			11.2	6.52	10.2
11	11.8			11.9	6.93	—
12	13.0			12.9	7.38	11.2
13	14.0			13.8	7.93	12.7
14	14.4	11.3		14.3	8.62	
15	15.3			15.1	9.15	
16	16.6			16.2	9.70	
17	18.0			17.4	10.20	
18	19.5			18.5		15.7
19	19.9	17.5		19.2		15.7
20	21.3	18.6		20.4		
21		19.8				
31						19.7

* Litter sizes.

upon the capacity of the mother to supply food. Such a relationship has been previously demonstrated by Parkes (1926) who found an inverse correlation between litter size and growth rate in the white mouse. The residual trend towards larger litter growth rates in the larger litters as seen in Table 3 could not be accounted for by differences in the weights of mothers.

Figure 1, B shows the mean growth curve for the six litters of *Clethrionomys* (39 mice) during the first 20 days after birth together with average values from the lesser amounts of data on the other species (Tables 1, 2). Values from the literature for several "temperate" forms are also compared in Figure 1, B. A correlation with weight is seen with the smaller mice, *Mus*, *Peromyscus* and *Clethrionomys*, lying below the larger *Microtus* and *Dicrostonyx*. These differences are more apparent in terms of the linear growth constants, which are tabulated in Table 4 together with values for some additional species from the literature. These provide a good description of early growth except in the two southern species of *Microtus* whose growth curves show definite curvature. In *Peromyscus*, good linearity of early growth is seen in several species, and indeed, the extensive measurements of McCabe and Blanchard (1951) showed continued linearity of growth in three Californian species up to 35–40 days of age and 60–75 per

TABLE 3.—*Growth constants for litters of mice*

LITTER	NO. IN LITTER	INDIVIDUAL GROWTH GM./DAY	SY* GM.	LITTER GROWTH GM./DAY	WEIGHT† OF ♀ GM.
25	5	0.58	0.52	2.88	19.5
23	6	0.52	0.29	3.12	23.5
31	7	0.48	0.38	3.36	31.0
19	7	0.46	0.32	3.26	22.3
32	7	0.46	0.41	3.19	28.1
33	8	0.44	0.67	3.52	24.3
—	—	—	—	—	—
Clethrionomys	6.7	0.49	0.43	3.2	
Microtus	4	0.79		3.2	34.4
Dicrostonyx	3	0.76		2.3	

* Standard error of estimate; root mean square deviation from average curve, placed by inspection.

† 24–32 days *post partum*.

TABLE 4.— *Early growth constants for several species of mice*

SPECIES	ADULT WT. GM.	INITIAL GROWTH RATE		REFERENCE
		gm./day	%/day*	
White mouse	22	0.30†	1.4	Parkes (1928)
Peromyscus maniculatus	20	0.33	1.7	McCabe & Blanchard (1950)
P. maniculatus	22	0.40	1.8	Ryser & Morrison (1955)
P. leucopus	25	(0.43)‡	(1.7)	Ryser & Morrison (1955)
P. truei	28	0.40	1.4	McCabe & Blanchard (1950)
P. gossypinus	29	0.53	1.8	Pournell (1952)
P. californicus	40	0.60	1.5	McCabe & Blanchard (1950)
Clethrionomys rutilus	26	0.49	1.9	This study
Microtus guentheri	43	0.70	1.6	Bodenheimer (1949)
M. oeconomus	45	(0.79)‡	(1.8)	This study
M. pennsylvanicus	48	0.80†	1.7	Hamilton (1937)
M. californicus	62	0.98†	1.6	Selle (1928)
Dicrostonyx rubricatus	50	(0.76)‡	(1.5)	This study

* Referred to average adult weight.

† 12 day average; others represent 20 day average.

‡ Parenthesized values represent only one or a few litters.

cent of the adult weight. Since the absolute weight is a linear function of time $dW/dt = c$) it follows that the specific or relative growth, dW/Wdt, falls off rapidly during this period. In *Clethrionomys*, for example (Fig. 1, B), the specific growth rate was 29 per cent per day at birth but only 5 per cent per day at the 17th day.

Body Temperature.—Young *Clethrionomys*, in common with many other mam-

mals and birds, have lower body temperatures than the adults even though kept within the insulation of the nest and usually in contact with the mother. In ten-day-old mice the body temperature averaged 35.4°, or 3° below the adult level of 38.3° (Fig. 1, C). Although the variability of the body temperature in the young animals was considerably greater than in the adults (σ = 1.43 vs 0.87°), the difference between these two mean values or between 7–14 and 23–34 day animals was highly significant. The average temperature at 23–34 days was not significantly lower than in the adults. The four smallest of 46 trapped *Clethrionomys* that were weighed immediately after capture ranged from 10.7–11.4 gm. On the basis of the information on litter growth in captivity (Fig. 1, C and Table 1) this weight (11 gm.), corresponds to an age of 18 days. Thus the young were apparently free-living prior to reaching the adult temperature.

Scattered body temperatures for young, nesting *Microtus* and *Dicrostonyx* are shown in Figure 2, A. The 12-day-old *Microtus* had a temperature 1.7° below the adult level of 38.9° and the 10-day-old *Dicrostonyx* had an average temperature of 36.8 or 1.5° below the adult level of 38.3°. In the latter, the level had risen to 38.7° or nearly half a degree above the adult level by the 19th day. Such elevated temperatures in young animals have been found in other species e.g., man, sheep, rats and mice, and other rodents, (Clausen, 1928; Sumner, 1913; Ryser and Morrison, 1955).

Cold Resistance.—The response of young *Clethrionomys* to exposure at 0° for 60 or 90 minutes is shown in Figure 2, B as a function of age. When 11–13 day old mice were exposed to 0°, losses of 25–30° occurred and the body temperatures dropped to 3–16°. It can be seen that regulation was improved at the 13th day and by the 14th day a rapid transition was taking place with some animals regulating fairly effectively while others were ineffective as before. This heterogeneity continues through the 17th day but on the 18th day all of the mice were successfully regulating. This represents the earliest age at which the young mice were captured.

In Figure 2, C the 37 values have been averaged according to the 6 individual litters and distinct differences are seen. Litter No. 32 and particularly No. 31 showed slower than average development and regulated poorly even on the 16th and 17th day. Both of these litters showed average rates of growth. The curve for litter No. 31 shows the rapidity with which the ability to regulate temperature may be acquired. Within two days the mice have changed from all poor to all excellent regulators. Since some heterogeneity must exist even within a single litter, the development of regulation in individual mice must be even more rapid as is suggested by the light bounding curves in Figure 2, B.

In litter No. 33 the 12 day old mice were considerably more sensitive to exposure than the 11-day-old animals. This probably does not represent the natural situation but reflects the effect of the previous days exposure. A similar effect has been observed in very young pheasants (Ryser and Morrison, 1954), but the cause is not known. It may represent an exhaustion of energy reserves which were only partially restored within the 24-hour period. Older animals are not thus adversely affected by cold exposure even though their body temperature is reduced.

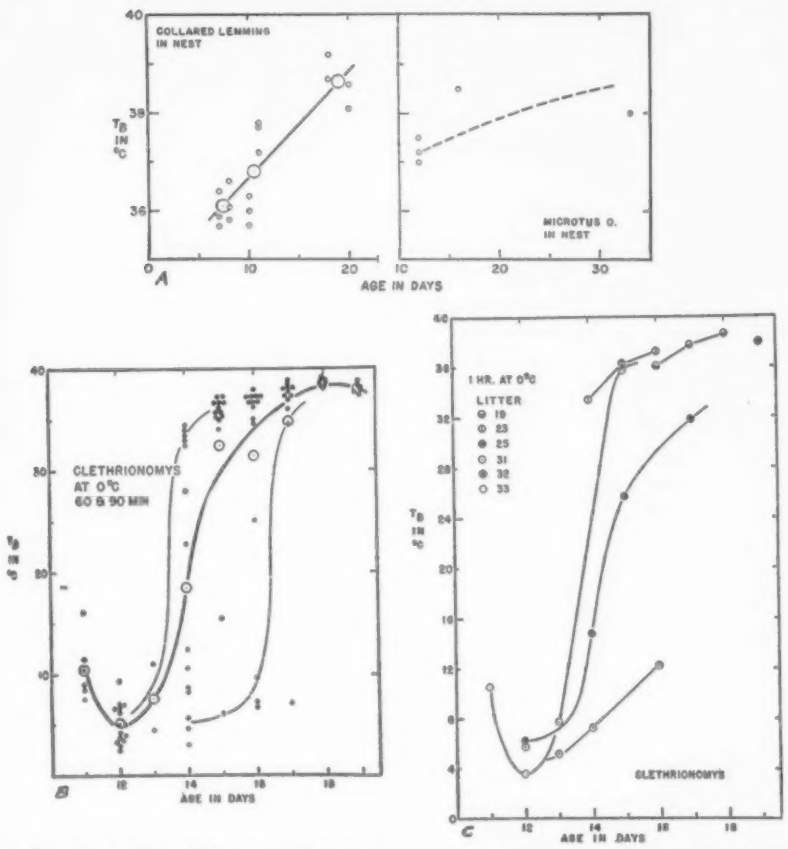

FIG. 2.—A: The relation between body temperature in the nest and age in *Dicrostonyx* (16 measurements on 3 young from 1 litter) and *Microtus* (5 measurements on 3 young from 1 litter). Significance: 7–11 vs. 18–20 days in *Dicrostonyx*, $t = 5.25$, $P = < .0001$.

B: The body temperature after exposure at 0° for 60 or 90 minutes as a function of age in *Clethrionomys*. Open circles show average values for groups of individual measurements. The heavy curve follows average values. The light curves show bounds for development in early and late individuals. 90 measurements on 38 young from 6 litters. Significance: 12–13 vs. 14 days, $t = 3.90$, $P = < .0005$; 14 vs. 15 days, $t = 3.18$, $P = < .005$.

C: The body temperature after exposure at 0° for 60 minutes as a function of age. Average values for litters of 5–8 individuals.

As might be expected, the fall in body temperature is influenced by the duration of exposure to cold. Thus, in Figure 3, A the curve for 90 minutes exposure lies slightly below that for 60 minutes and a single point (average of 6 young) indicates that the curve for 135 minutes was still farther below. However, these differences were small relative to the overall fall in temperature and consequently the 60 and 90 minute values were averaged in Figure 2, B.

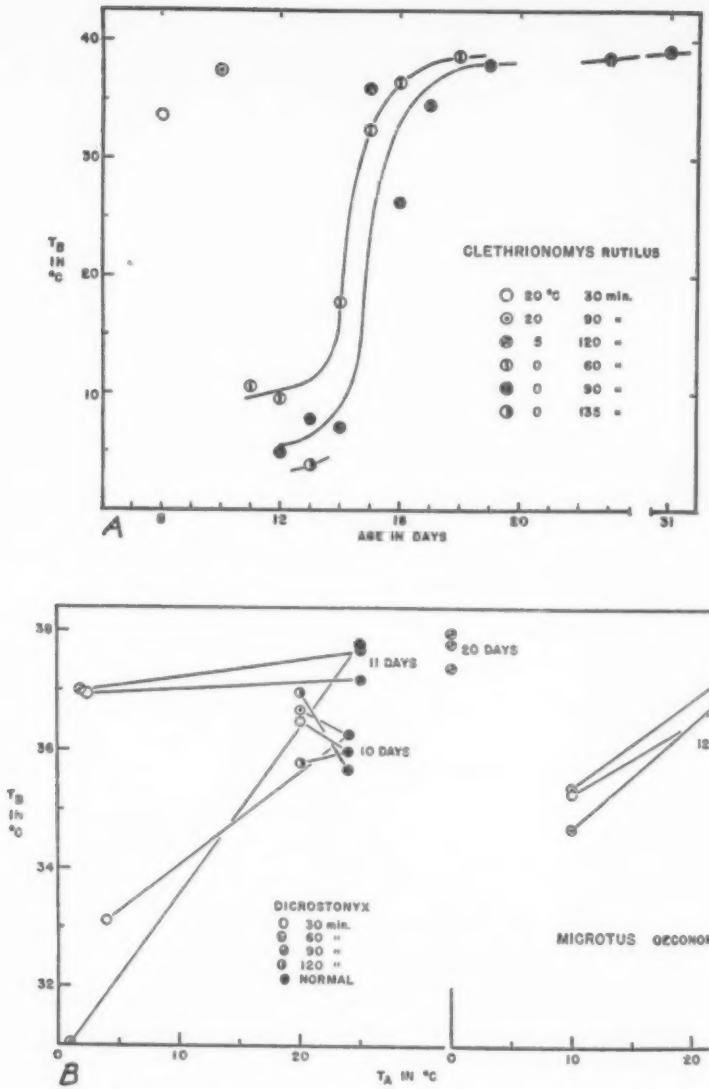

FIG. 3.—A: The body temperature after exposure to cold as a function of age in *Clethrionomys*. Circles show an average value for groups of individual measurements. 111 measurements on 43 young.

B: The body temperature after cold exposure in *Dicrostonyx* and *Microtus*. The age is indicated beside the symbols.

The more limited data on response to cold in the other two larger Alaskan species are summarized in Figure 3, B. At 11 days of age some of the young lemmings regulated well at ambient temperatures of as low as 2–4°. However this would appear to be a critical age since lemming No. 5, dropped almost 4° when exposed 30 minutes at 4° on the 10th day, but regulated at 2° for 30 minutes with less than a degree drop in body temperature on the 11th day. In contrast, the meadow mouse showed poor regulation at 12 days, falling 2° after 30–60 minutes at 10°. By 20 days it could stand exposure to 0° successfully.

SUMMARY

Growth and the development of temperature regulation was studied in 37 young from six litters born to pregnant, wild-caught, redback voles, *Clethrionomys rutilus dawsoni*. During the first 20 days, linear growth curves with a mean slope of 0.49 gm./day were observed. The young *Clethrionomys* had a lower average temperature than the adults even though living in a warm nest and brooded by the female. At ten days this temperature averaged 35.4° as compared to the adult average of 38.3°. Not until the twenty-eighth day was the average temperature equal to that of the adults. After exposure to an ambient temperature of 0° for 60–90 minutes, body temperatures in 11–12 day voles ranged from 2.5° to 16°. These low temperatures were experienced without subsequent visible ill effects. By the fourteenth day there was great improvement and on the eighteenth day all the young were regulating successfully. The transition from poor to good regulation was often very rapid but varied in different litters, ranging from two days in litter No. 31 to five days for litter No. 25. Of 46 wild-trapped voles the four smallest weighed 10–11.4 gm., a weight reached in laboratory born young at about eighteen days. Thus, young *Clethrionomys* do not leave the nest until temperature regulation is well developed.

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LOCOMOTION IN POCKET MICE

BY GEORGE A. BARTHOLOMEW, JR. AND GRANT REYNOLDS CARY

The present investigation of locomotion in pocket mice of the genus *Perognathus* is an outgrowth of an earlier study of locomotion in kangaroo rats (Bartholomew and Caswell, Jour. Mamm., 32: 155–169, 1951). It was undertaken in the hope of elucidating some of the factors associated with the evolution of bipedalism in desert rodents. The family Heteromyidae is of particular interest in this respect because it contains two highly specialized genera, *Dipodomys* (kangaroo rats) and *Microdipodops* (kangaroo mice), which are characterized by bipedal locomotion, as well as a third, less extremely specialized genus, *Perognathus* (pocket mice), which has been assumed to be characterized by quadrupedal locomotion.

Pocket mice possess many of the special anatomical adaptations typical of kangaroo rats and kangaroo mice—enlarged hind legs, reduced front legs, pronounced cervical flexure, long tail often equipped with a terminal brush, enlarged auditory bullae, and a dorsally oriented field of vision. Pocket mice and kangaroo rats occupy similar habitats over most of the desert areas of southwestern North America. They exploit similar food sources in a similar manner, and are preyed upon by many of the same predators. As Hatt (Bul. Amer. Mus. Nat. Hist., 63: 607, 1932) has pointed out, *Perognathus* represents a morphological type from which bipedal locomotion of the sort shown by *Dipodomys* probably was evolved. Consequently an analysis of the patterns of locomotion of pocket mice should contribute to an understanding of the evolution of bipedalism in desert rodents.

Locomotion in four species of pocket mice, *P. longimembris*, *P. formosus*, *P. fallax*, and *P. californicus*, was studied in the laboratory by direct observation, high speed still photography, and cinematography. Still photographs were taken with a press-type camera and an electronic flash unit; a few pictures were made with a repeating flash unit that allowed the superposition of a number of images on a single negative. All photographs were taken through the glass front of a cage, five feet long and one foot deep, the bottom of which was covered with sand. Several animals, often of more than one species, were placed in the

cage together and photographs were taken when one or more moved across the field of view. Most of the pictures of erratic leaping were made when one mouse attempted to avoid the aggressive actions of another. High speed straightaway locomotion was studied by startling mice into running the length of the cage.

We are grateful to William N. MacFarland, R. B. Rich, F. Alton Everest, and particularly to Albert D. Ruby for assistance in various parts of this study.

RESULTS

The species of pocket mice that we studied appear to be exclusively quadrupedal. At no time did we observe or photograph bipedal hopping of the sort typically used by kangaroo rats and kangaroo mice.

When traveling slowly, pocket mice usually walk with alternately moving legs (Pl. I). Occasionally this walk is accelerated to a trot (Pl. I). When moving at moderate speed pocket mice typically employ a quadrupedal hop in which the two hind legs move together and the two front legs move together (Pl. I). This quadrupedal hop is the same general locomotor pattern shown by many small rodents and is similar to that employed by some slowly moving kangaroo rats (Bartholomew and Caswell, *loc. cit.*).

When a pocket mouse travels rapidly in a straight line, the quadrupedal hop is extended to a gallop in which the front legs strike the ground together, followed closely by the long hind legs which swing far forward, overreach the point of contact of the front feet, and then propel the animal in a powerful leap. Thus a rapidly moving pocket mouse moves in a series of long leaps, springing from its elongate, powerful hind legs and landing on its front feet, which appear to contribute only slightly or not at all to its forward momentum (Pl. II). All stages between the quadrupedal hop and the gallop are employed depending on the mouse's speed and momentum.

When suddenly disturbed or when frightened, pocket mice typically initiate a series of powerful leaps in which the direction of movement changes repeatedly in an unpredictable manner. Some of these leaps carry the animals 24 inches or more vertically and as much as a yard horizontally. The evasive leaps are so rapid and erratic that it is impossible to follow them by eye. However, with single and multiple electronic flash photography a number of pictures of this type of locomotion were obtained; in all instances the mice landed front feet first (Pl. III).

The long tail of a pocket mouse is of course used as a balancer. During erratic leaps it may swing forward over the back or along the side until its tip extends beyond the mouse's head. During a rapid straightaway gallop the tail describes a series of vertical undulations presumably of a balancing nature (Pl. II). In the early stages of a long leap the tail extends out straight behind like a rudder. When a pocket mouse stands on its hind feet with its body vertical it sometimes uses its tail for partial support, but this posture is never as conspicuously tripedal as that shown by kangaroo rats.

Like kangaroo rats and kangaroo mice, pocket mice forage widely for food. The desert species characteristically search for seeds on the surface of the sub-

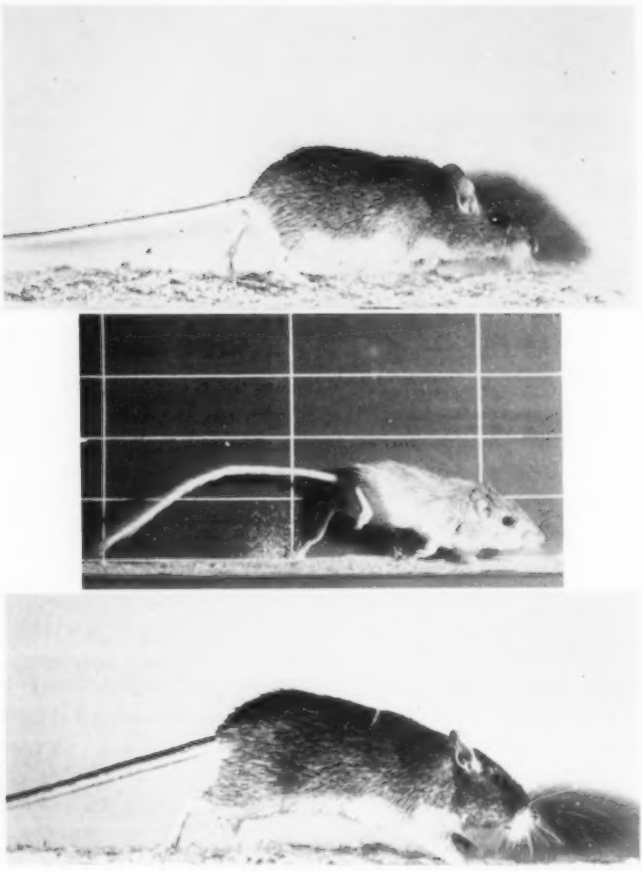

PLATE I

UPPER: *Perognathus californicus* moving slowly in a typical quadrupedal walk. MIDDLE: *Perognathus fallax* employing a quadrupedal trot. LOWER: *Perognathus californicus* employing a slow quadrupedal hop.

strate, or in the top layer of loose sand or soil. The front feet, which are equipped with long claws, sift the soil, and with great rapidity place the seeds gleaned from it in the external, hair-lined cheek pouches. During this process the animal's posture is bipedal. It balances on its hind legs with its long hind feet roughly beneath its center of gravity; the axis of its body is almost horizontal and the ventral surface of the head is close to the ground. (This posture differs markedly from that of most non-heteromyid and non-geomyid rodents which, while sitting or standing on their hind legs, usually tilt the body upward and hold the head

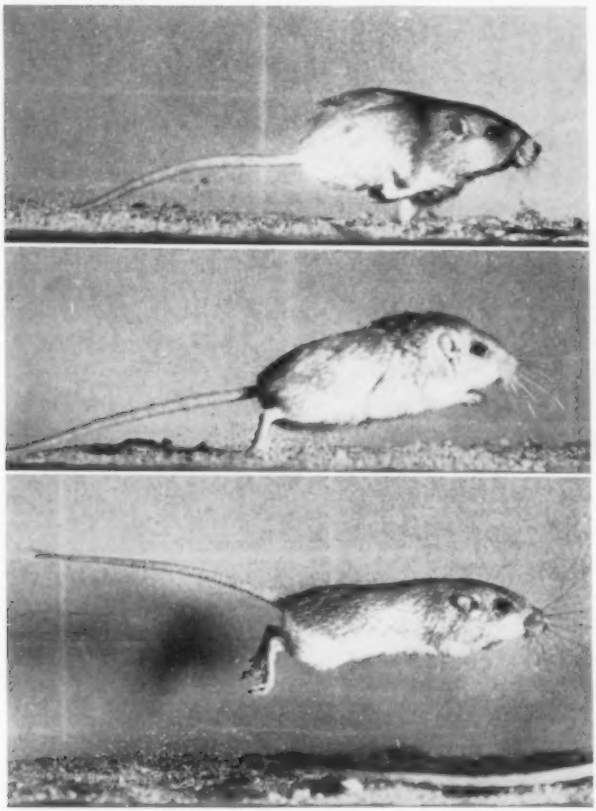

PLATE II

Three stages in fast straightaway locomotion in *Perognathus longimembris*, showing the use of the front feet, the overreach of the hind legs, and the powerful leap.

some distance from the ground.) From time to time the hind legs push to the rear the dirt or sand that has been sifted by the front feet.

The four species of *Perognathus* showed no conspicuous differences in the major patterns of their locomotion, but obvious differences in temperament were reflected in their movements. *P. californicus*, the largest of the pocket mice studied, was relatively phlegmatic, made few long leaps, and walked more frequently than any of the others. *P. longimembris* was relatively excitable and made long erratic leaps, while *P. formosus* and *P. fallax* were of intermediate excitability. All four species of pocket mice were noticeably less high strung than *Peromyscus maniculatus* studied under similar conditions. Locomotion in *Peromyscus* was used to obtain a picture of quadrupedal locomotion in a generalized

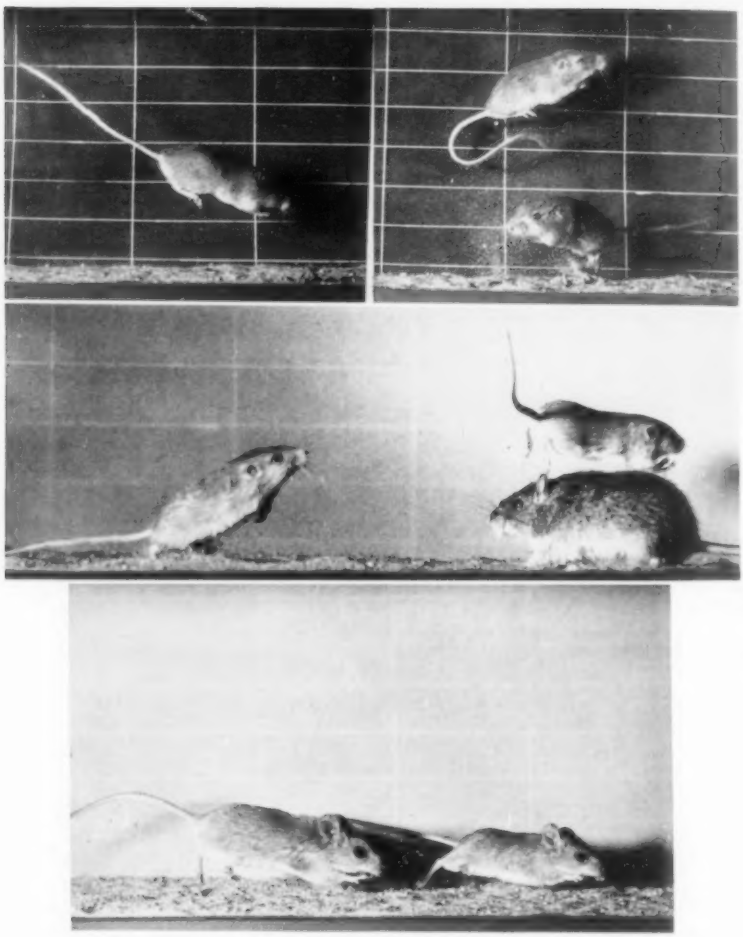

PLATE III

UPPER AND MIDDLE: Erratic leaping in *Perognathus*. Notice use of the tail as a balancer and use of the front feet in landing. LOWER: Fast straightaway locomotion in a mouse of generalized morphology, *Peromyscus maniculatus*.

type of rodent. Typical positions during high speed locomotion are shown in Plate III.

DISCUSSION

Our observations show that despite their anatomical similarity to kangaroo rats and kangaroo mice, pocket mice are no more bipedal in their locomotion

than most other rodents. However, their elongate hind legs facilitate leaping, and together with their long hind feet allow them while foraging to assume a horizontal bipedal posture which frees the front legs for sifting through sand and soil for food.

The anatomical adaptations of pocket mice parallel those of kangaroo rats, the food habits and habitat preferences of the two genera are similar, and pocket mice are at least as successful in numbers of individuals and numbers of species as kangaroo rats. Why should one be bipedal and the other quadrupedal?

Hatt (*loc. cit.*: 607) stated that the "ricochet [bipedal leaping] evolved from quadrupedal saltation at a time when the overstep of the rear feet became so great that the contact of the fore feet impeded the advance of the mass as a whole." If so, *Perognathus* may represent a type not yet impeded while *Dipodomys* may represent a type that has passed this critical point.

Although Hatt's suggestion certainly has merit, we feel that non-locomotor factors may well have been associated with the assumption of heteromyid bipedalism, although of course assignment of primary causality is impossible. The rarity of bipedal saltation among placental mammals suggests that in most situations it is less effective than quadrupedal locomotion; certainly it is less efficient mechanically. Consequently general locomotor efficiency need not have been primarily responsible for natural selection's operating in favor of bipedalism in heteromyid rodents.

The characteristic food gathering techniques of heteromyids in which they search, apparently using only tactile and olfactory clues, for seeds lying on or buried just beneath the surface of loose soil or sand, places a premium on front legs adapted for food handling and soil sifting. The large hind legs and long hind feet allow foraging pocket mice to assume a horizontal bipedal posture with head close to the ground, which frees the front legs for sifting soil and for food handling. The possibility exists that natural selection for increased length of hind legs was associated primarily with the specialization of the front feet for feeding and only secondarily with saltation. If so bipedalism in heteromyid rodents could have evolved with locomotor efficiency playing a subsidiary role.

It has been suggested (Bartholomew and Caswell, *loc. cit.*) that one value of the complex of adaptations associated with bipedalism in *Dipodomys* lies in allowing quickly mobilized, rapid, and erratic escape movements over short distances in open terrain. The escape responses of kangaroo rats and pocket mice are similar—long erratic leaps in which direction is changed in an unpredictable manner. Such a reaction is facilitated by the long, powerful hind legs characteristic of both genera, and such large, hind legs also make possible the style of food gathering of both genera. Beyond this one can only speculate. It is easy to see how the general body proportions of heteromyids could result from natural selection associated with their food gathering habits; it is much more difficult to envision factors that would cause some heteromyids to become bipedal—increased size alone could hardly have been the factor because several species of the quadrupedal *Perognathus* are larger than the bipedal *Microdipodops*. On the basis of evidence presently available, however, it is clear that

pocket mice, which are strictly quadrupedal in locomotion and bipedal while sifting for seeds, are clearly preadapted for bipedal locomotion. We suggest that the evolution of bipedalism in heteromyids was basically a by-product of the specialized foraging habits and that strictly locomotor factors may well have been of secondary significance.

SUMMARY

Locomotion in four species of pocket mice (genus *Perognathus*) was studied in the laboratory by means of observation and photography. The members of all four species were exclusively quadrupedal in locomotion. However, their elongate hind legs facilitated leaping, and, together with their long hind feet, allowed them while foraging to assume a horizontal bipedal posture that freed their front feet for searching through the soil for food.

The possible evolution of bipedalism in heteromyid rodents is discussed; it is suggested that it may have been primarily a by-product of the specialized foraging habits and that strictly locomotor factors may have been of secondary significance.

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HOME RANGE AND MOBILITY OF BRUSH RABBITS IN CALIFORNIA CHAPARRAL

By Joseph H. Connell

The brush rabbit, *Sylvilagus bachmani*, is one of the commonest game mammals in the chaparral areas of California. It is widely hunted for sport and for food, yet surprisingly little has been published on its natural history. This study was undertaken to learn something of the mobility of brush rabbits in a natural chaparral habitat near Berkeley, California. Trapping and marking of animals in a more or less isolated unit of habitat was the principal method of study. The period of trapping extended from March, 1948, to May, 1949; 40 rabbits were marked. Incidental data on population density, breeding period, and physical condition of trapped animals were obtained and are summarized in this report.

Area of study.—The area used for this study is a canyon located in the Berkeley Hills immediately southeast of the University of California campus; its position lies at the head of Dwight Way in Berkeley. The main drainage is to the west with steep sides rising from 300 to 800 feet elevation on the western spurs, which unite at about 1,200 feet at the east. Water is available only in late winter and spring in the main creek bed. The drainage basin contains about 30 acres, near the center of which the study area of approximately 11.4 acres is located. The latter area, composed of chaparral and adjoining grassland, is the only part of the basin suitable for occupancy by brush rabbits. The other principal vegetation types are grass and trees (Fig. 1). Light grazing of the area had been permitted in past years but was eliminated several years before the period of study.

The brush area lies mostly on the north-facing slope, with coyote brush (*Baccharis pilularis*) the dominant shrub. Coffee-berry (*Rhamnus californica*) is common, with poison oak, cow parsley (*Heracleum lanatum*) and elderberry (*Sambucus glauca*) in the more humid draws. Bush monkey flower (*Diplacus aurantiacus*) occupies edges and dry openings in the brush. Along the main creek bed is a riparian association of willow (*Salix* sp.) with other brush of the beforementioned species and a ground cover of blackberry (*Rubus vitifolius*).

The grass type is dominant on hill tops and on the xerophytic south-facing slope of the canyon. Principal components of the type are native and introduced grasses (*Avena*, *Bromus*, *Festuca*, etc.), and various forbs of which thistles (*Cirsium* sp., *Centaurea* sp.), tarweed (*Madia sativa*), soap plant (*Chlorogalum pomeridianum*), bur clover (*Medicago hispida*) and filarees (*Erodium* sp.) are among the dominants. The grass area has been burned each year in August for the past few years by the local fire department. Mixed in the herbaceous growth are scattered bushes of California sagebrush (*Artemisia californica*), poison oak (*Rhus diversiloba*) and lupine (*Lupinus* sp.).

Trees occur in the lower stream bed, mostly California laurel (*Umbellularia californica*), with a few coast live oaks (*Quercus agrifolia*) and buckeyes (*Aesculus californicus*). A few small laurel trees are scattered in the brush on the north-

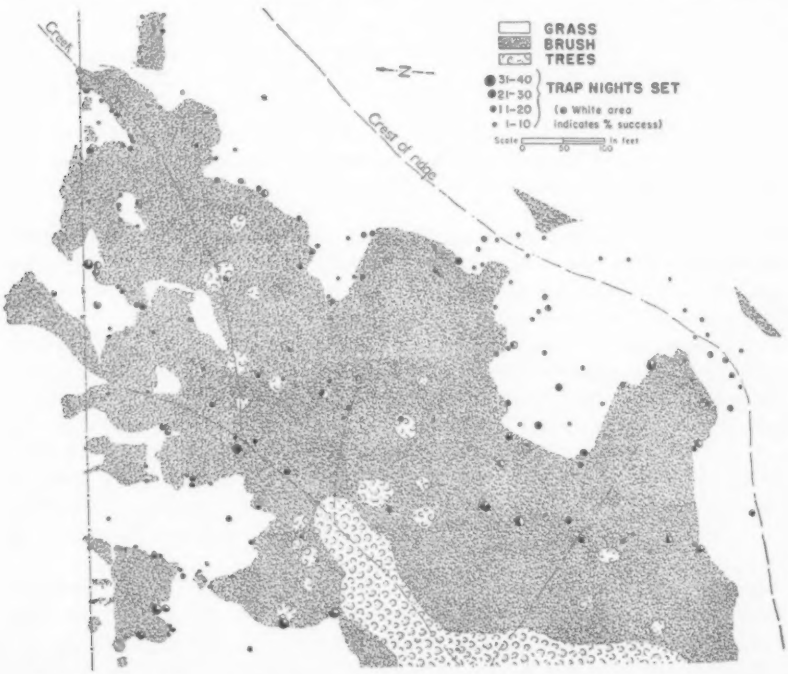

FIG. 1.—Vegetation map of the study area, showing distribution of trapping effort.

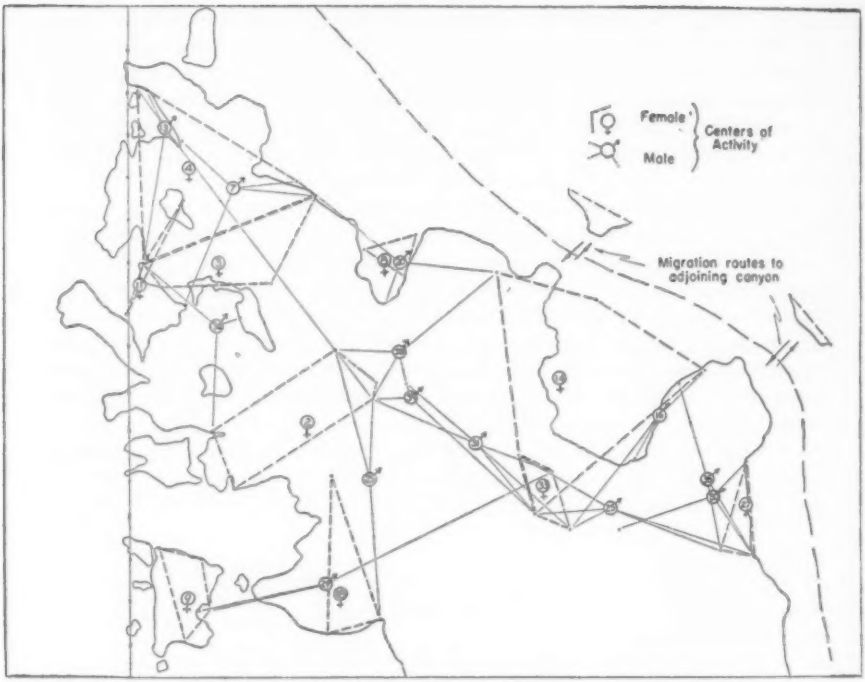

FIG. 2.—Outline of chaparral area with trap-revealed ranges and computed centers of activity of rabbits captured three or more times.

facing slope. In the lower parts of the gulch (where, incidentally, no trapping was done) various exotic trees such as *Sequoia*, *Eucalyptus* and *Acacia* have been planted. Additional brush species found there include hazelnut (*Corylus rostrata*), creambush (*Holodiscus discolor*) and wild rose (*Rosa gymnocarpa*).

In general, the rabbits used the brush area for cover and feeding, the grass area adjoining the brush for feeding, and the wooded areas for transit only, since few pellets were found there. The broad grass area above the brush seemed at first to provide an effective barrier to the ingress and egress of rabbits from the area, but subsequently runways were found linking the brush area in the upper canyon to brush in the next canyon south (Fig. 2). Trapping in the spring in these runways failed to capture any migrating rabbits, but the numbers of pellets and runways seemed conclusive evidence of some movement in and out of the area.

Except for the writer, relatively few people visited the area. There is one poorly defined path up the main creek bed. Only those rabbits that died in the traps were removed from the study area. No hunting or snap trapping was done.

Trapping procedures.—Home-made Wellhouse traps, 6″ x 6″ x 20″ with one end closed, and Young traps measuring 4½″ x 5″ x 18″, open at both ends, were

used. The best bait seemed to be rolled barley since the large-sized particles did not fall through the hardware cloth of the traps as commercial rabbit pellets did. The dry condition made the barley more constant in appeal than fresh bait that quickly dried.

Prebaiting to allow all the population to become familiar with the traps is recommended by Chitty and Kempson (1949) and others. This was tried, first putting bait in likely locations, then with a trap wired open with bait. When the trapping began, no more success was achieved at prebaited locations than at others. Sometimes a trap placed in a new location caught a new rabbit the first night. The data show that two females and five males were caught initially in traps placed in position the first night, without prebaiting. The traps had caught rabbits previously in other locations, so were "seasoned." Four other rabbits were caught the second or third nights after placing the traps. Therefore, of the forty rabbits caught in this study, one-fourth were caught for the first time in newly-placed traps. It appears that unfamiliarity with traps does not deter brush rabbits from entering. Unsuccessful trapping was probably due to incorrect placing of traps rather than to wariness of the animals or lack of prebaiting.

The rabbits were marked by tatooing a number inside both ears with a steel quill pen using Higgins Eternal Ink. This method is especially suitable for species like *Sylvilagus bachmani* and *Sylvilagus audubonii* that have little hair inside the ear. The tatooing, as recommended by Allen (1939), caused no infection or damage and lasted in one case over three years. For handling, the animals were placed in a cloth bag with a drawstring opening. Individual animals were weighed, marked (when first trapped), sexed, measured, and inspected for condition and parasites at each handling. No valid criterion for age was found in either the weights or measurements.

Some rabbits injured themselves in the traps, lacerations and broken toes being fairly common. Nine deaths can be attributed to trapping. One rabbit was killed by a spotted skunk (*Spilogale gracilis*) that entered one of the Wellhouse traps. Eight died, presumably from exposure coupled with "shock."

OBSERVATIONS

Validity of trapping in tracing movements.—The three main factors affecting the validity of this trapping study were the irregularities of time and trap positions, the acquiring of a "trap habit" by some individuals, and the general question of the trap line as a means of sampling.

Table 1 summarizes the trap nights as they were distributed in the three main divisions of the habitat throughout the year. Figure 1 shows the distribution of trapping intensity in relation to vegetation types. Trapping was heaviest in the spring. In no month were traps set more than 15 nights, usually less than 10.

The positions of the traps were changed approximately every two and one-half weeks, with about one-third of the traps being moved at each moving period. The most successful traps were usually not shifted. This procedure allowed some individuals to develop a "trap habit," which resulted in more captures. An analysis of trap success as compared to the length of time that the trap was left in one position is shown in Table 2. Traps left more than three weeks in position were more successful than those shifted more frequently. The difference in success between leaving a trap three weeks in one place rather than five or

TABLE 1.—*Summary of trap nights in relation to vegetation types*

TYPE	MAR.	APR.	MAY	JUNE	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JULY	TOTALS	%
Grass-herb	—	—	—	—	67	66	8	16	3	77	93	84	86	1	471	21
Edge of brush	20	112	71	36	89	220	67	106	56	85	86	82	158	11	1169	52
Brush interior	—	—	—	—	—	7	11	39	54	140	128	63	160	9	611	27
Monthly totals	20	112	71	36	156	293	86	161	113	302	307	169	404	21	2251	
Per cent of total trap nights	1	5	3	2	7	13	4	7	5	13	14	8	18	1		

six weeks is so slight, however, that no real inaccuracy would appear to result from the practice of leaving a trap in a favorable position for several weeks.

The real danger from this practice is that an individual might become attracted to bait and so engage in an unnatural pattern of movement. Four rabbits seemed to have developed a trap habit. Female number 9 was caught 14 times in one trap within eight months, and seven times in other traps. Male number 21 was captured six times in two months at one trap, then nine times in two months at another. Female number 11 was caught in the same trap six times (out of eight trap nights) within 18 days; male number 35 likewise was taken five times (six trap nights) in nine days.

Whether a trap line gives a valid indication of animal numbers in an area is a much argued question. The steepness of terrain and density of brush made the quadrat method of trap deployment too difficult in this area. Various workers have criticized both line and quadrat methods, but the more systematic quadrat system is usually agreed to be better. Calhoun's recent cooperative study uses the trap line as a good, easily analyzed method. Stickel (1948*a*) points out, however, that a trap line can capture any individuals that are within the distance of their "cruising radius" of the line, hence it follows that such a line samples an area equal to the cruising radius (or one-half the diameter of an animal's home range) on both sides. Since this radius is usually smaller for females (as it is for *Sylvilagus bachmani*), the actual area sampled is different between sexes of the same species. Likewise the radius tends to be larger in habitats where food is scarce, so the area sampled will also differ in contrasting habitats or in the same habitat at different seasons of the year.

Another aspect of the problem is that, postulating equal numbers of males and females in an area, the greater area of "male sampling" will result in more males being caught by a given trap line. Of course, in an area such as the present one, with definite habitat boundaries, all the animals in the area should be caught if the period of trapping is long enough. Later discussion will show that such was probably the case in this study.

Restriction of movement by any arrangement of traps is emphasized by Hayne (1949). Mohr (1947) advises shifting of a trap line to prevent such artificial restriction. Stickel (1948*b*) showed, conversely, that animals do not tend to be attracted into a new area by bait. In this study, conducted in a somewhat isolated area over a year's period, the problems of trap lines *per se* seem to be compensated for by the intensity and length of trapping.

The pellet census.—As a check on the trapping, pellet counts were made during May and June, 1949. This method has been advocated by MacLulich (1937) and Eadie (1948) as a

TABLE 2.—*The effect on trap success of leaving a trap in position; (Only those positions where captures were made were tabulated)*

No. trap nights in same position	1–20	21–30	31–40
No. of positions	31	17	11
Total trap nights	334	417	411
No. of captures	57	97	90
Success: $\frac{\text{Captures}}{\text{Trap nights}}$	0.17	0.23	0.22

relative census method. My concern was not census however, but rather checking the distribution of use in various parts of the area. Deterioration of pellets is assumed equal throughout the area. The distribution of the counting stations was determined by marking ten lines across the area at random distances apart, then arbitrarily distributing 100 stations at random distances along the lines, the number of positions on each line being proportional to its length across the irregular brush area. All distances were taken from a book of random numbers. At each station an area of one-quarter square meter was cleared of all litter and the rabbit pellets counted. The results are discussed in the next section.

Habitat preferences.—The rabbit activities of real significance revealed in this study can be classed into three groups: habitat preferences, movements between captures, and individual home ranges. A preceding section sets forth the limitations that should be kept in mind when considering the conclusions drawn about these activities.

Preference for various parts of the habitat was judged by the intensity of use of the grass and continuous brush areas, as reflected in trap success, pellet counts, and location of computed centers of activity. In addition, the line of juncture or edge between grass and brush was treated as a distinct type of habitat, and defined as the 10-foot-wide strip extending 2½ feet into the grass and 7½ feet into the somewhat scattered brush that makes up the chaparral border. No trapping was done under tree cover so this habitat is not considered.

For each individual caught in three or more different locations, a "center of activity" was computed as outlined by Hayne (1949). The difference in trapping methods necessitated a modification of his scheme as follows. A grid was superimposed on the plotted capture points of an individual and each point was assigned coordinates. Since the traps had been placed at the different capture points for varying lengths of time, the computed trap success ratio was the only way to show relative intensity of use of each point. Therefore at each position the number of captures of that individual was divided by the number of nights the traps were set there. Then each coordinate for the position was multiplied by the trap success figure, giving two *position-intensity values* for this position. The sum of these values (horizontal and vertical coordinates separately) for all points of capture gave two total position-intensity values, which, when divided by the sum of the trap-success figures, gave a resultant average set of coordinates that could be plotted as a point on the map. This point, embodying both intensity of use and geographical position, is the *center of activity* for the individual. The position of the center of activity in relation to different parts of the habitat is used as an indication of preference. Figure 2 shows the distribution of these centers of activity in the study area.

In Figure 3, the results of the three methods for judging habitat preference are graphically compared. The horizontal coordinate is linear distance measured from the edge of the brush. Both trap success and location of centers of activity show a concentration of use near the brush edge, with a rapid decline out in the grass area. However the pellet counts indicate an area of activity extending to about 40 feet from the edge, with some pellets occurring even 70 feet out. That this obvious activity was not reflected by trapping may be a result of an added wariness by the rabbits in the unprotected areas, with avoidance of unfamiliar objects such as traps.

Use of the interior of the brush seems to be irregular. In all three graphs, a peak of activity is shown 40 feet inside the edge. The low activity 15 to 20 feet inside may indicate a zone used only when moving from the greater protection of the continuous brush to the edge for feeding activity. The peak of activity shown by trap success at 100 feet inside the brush is not indicated by the other two analyses. This may reveal a flaw in trap-revealed activity if animals enter traps more readily in highly protected areas. No other explanation is forthcoming for this apparent contradiction in my data. In any event, some brush rabbits used all parts of the chaparral zone which was only 340 feet across at the widest point.

Figure 4, A illustrates the trends of trap success by months in the 10-foot-wide edge strip, and the grass and brush areas, as units, on either side. The peak of most successful trapping shifted from the grass area and adjoining edge in winter into the brush by March. This may be correlated with the winter growth and subsequent spring desiccation of the annual herb vegetation, with consequent greater use of the brush in the drier season. To observe

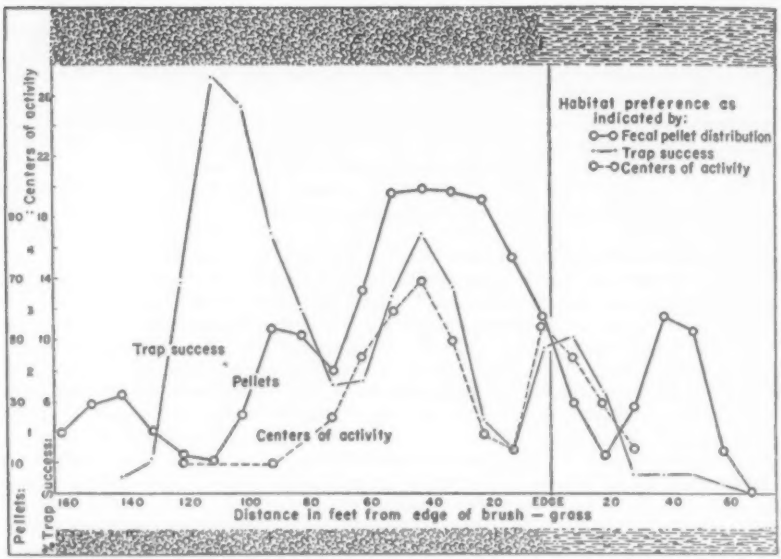

FIG. 3.—Use of the chaparral and grass as indicated by fecal pellet occurrence, success of trapping, and distribution of computed centers of activity.

the spring shift of rabbits from the grassy edge toward water courses deep in the brush, three individual ranges were plotted. Most of the captures near grass were made from September to February. Captures deeper in the chaparral were mostly made from March through May. These three were chosen because of the striking regularity with which they showed this tendency. However the others, though less clear-cut than these three, contributed to the general curve illustrated in Figure 4, A.

The three peaks of trap success shown in Figure 3, when analyzed for each sex, show three equal peaks for females, but for males show increasing success from the edge inward, with the high peak 100 feet in the brush produced mostly by male captures. The center of activity of male brush rabbits seems to be farther from the edge and closer to stream courses, indicating a preference for damper sites deep in the chaparral.

At this point it may be well to consider whether conclusions drawn from a small brush tract with a relatively large edge circuit can be applied to those areas composed of expanses of continuous chaparral. The fecal pellet counts showed that all the brush area was used to some degree. However, the activity peaks at the edge and in the herbaceous vegetation would seem to suggest a decided preference for a discontinuous brush-herb situation. Mixed chaparral and grass is probably better habitat for brush rabbits than continuous chaparral.

Day-to-day movements.—Short-term movements between capture points may give some idea of the daily mobility of brush rabbits, as distinguished from seasonal shifts just discussed. Distances between successive capture points, when less than 10 days had elapsed between the captures, were averaged and plotted as shown in Figure 4, B. Females made their longest moves from December to February, males in February–March and in May, when females moved least. The care of young may curtail female movements in the spring. Summarizing the day to day movements between captures, females averaged 66 ± 10 feet and males 81 ± 15 feet, a non-significant difference.

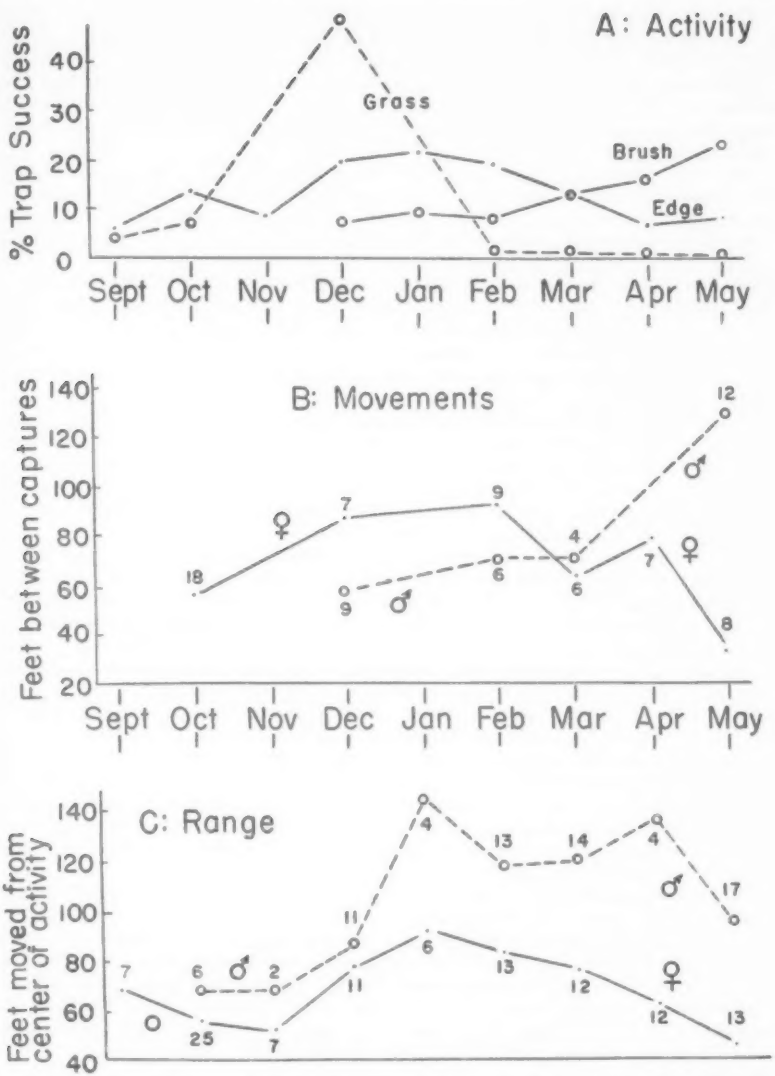

FIG. 4.—Seasonal changes in behaviour: A. Preference for habitat type; B. short term movements; C. distance ranged from center of activity. The numeral at each point indicates the number of measurements that were averaged to obtain the value.

Individual range measurements.—An individual home range is defined by Burt (1940) as the area traversed in the normal activities of food gathering, mating, and caring for young. Whether the area delineated by plotting a set of capture points on a map adequately approximates this range is highly debatable. However, the attitude of Stickel (1946) that "actual movements of the animals in the given area in the given period are the item of importance in attempting to derive figures on populations," may be held as an aim in the following discussion.

The ranges revealed by trapping are plotted on a map (Fig. 2). The map includes all individuals caught up to March, 1949, in three or more positions; the number of the individual is placed at its center of activity position. For contrast, the outer points of capture of females are connected, while each male's points of capture are joined to the center of activity for that animal. Ranges of the females overlap much less than those of the males (three overlaps as compared to 11 for the 23 rabbits plotted.) If all 40 rabbits are included, there are only five cases of female ranges overlapping as compared to 13 for the males. Five females had completely separate home ranges, but no male enjoyed this isolation. Female brush rabbits seem to be arranged in a semi-territorial pattern, each female occupying a fairly discrete area. However, since no direct observations were made, it is not known whether these areas are defended.

Size of home range was computed by averaging distances of capture from the computed center of activity. For 10 females and 10 males caught before April, 1949, in three or more positions, radii were drawn from the computed center of activity to the capture points. When these data are summarized for the whole period of study, the females averaged 69 ± 8 feet, the males 115 ± 10 feet from their respective centers of activity. In other words, the home ranges of males are significantly larger than those of females.

Since ranges may change with season and with other aspects of behavior, the distance ranged from center of activity was summarized by months, as shown in Figure 4, C. The male range is larger at all times, but much more so during the breeding season. The decline in range size among males from April to May is in apparent contradiction to the concurrent lengthening of male short-term moves, shown in Figure 4, B. A possible explanation is that at this time the seasonal shift across the diameter of the individual range is being made, from grass edge deeper into the chaparral (Fig. 4, A). Although the shift may occasion fairly long movements, these are not movements away from the yearly center of activity, but in the vicinity of it. The spring change in female range is more gradual.

Burt (1940) used the greatest diameter of range as one indication of relative size. A summary of this measurement for the 10 females and 10 males used above gave 169 ± 22 feet for the females and 290 ± 31 feet for the males, the difference again being significant.

A possible areal indication of home range might be the area of a circle whose radius is the average distance from the center of activity. The resultant areas are 0.34 acres for the females, 0.95 acres for the males; 0.64 for both sexes together.

Blair (1943) considered that an animal had been trapped over most of its range if further captures did not increase the area indicated by plotting the capture points. In this study, four individuals, all females, were trapped one or more times after their range, as revealed by trapping, had ceased to increase. Averaging the figures for these four female rabbits showed that for three months and five captures their range did not increase further in size. The distance moved from center of activity was 63 feet, a figure which falls within the significant range for all females, 69 ± 8 feet. In summary, the ratio of female to male values was 0.6:1 for both distance from center of activity and greatest diameter of range; the area ratio was 0.36:1.

Breeding season.—The increase in size of the testis of the male was the measure used to indicate the onset of the breeding season. Although the limits of the breeding season are probably controlled by the condition of the female, the only quantitative data secured were male testes sizes. Of the females that were trapped, none was recognized as being pregnant, and examination of nipples at each capture did not reveal nursing by females.

The measurement of testes of live rabbits in the field was possible only after the testes

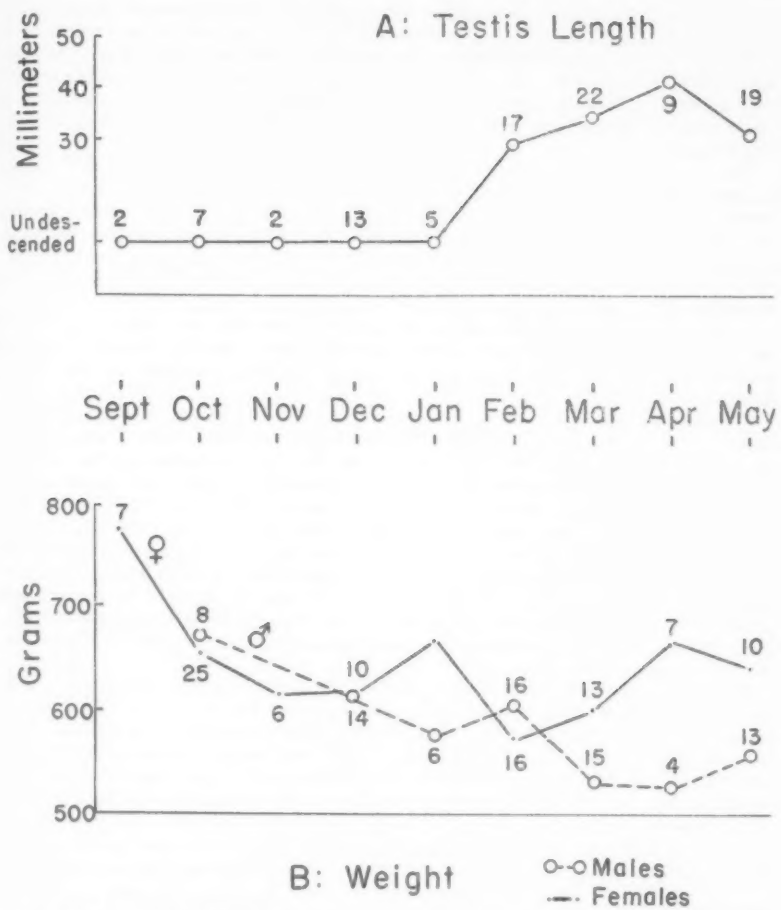

FIG. 5.—Seasonal variation in testis size and individual weight: A. Male breeding condition; B. weight difference between the sexes. The numeral at each point indicates the number of measurements that were averaged to obtain the value.

had descended. Testes were not found in the fall or winter until February 1, when, after a lapse in trapping of 18 days, four males were captured with descended testes. According to these data, the onset of the breeding condition in males can be placed in the last half of January in 1949. Figure 5, A shows monthly averages of testis length. The peak of size in April, though based on fewer measurements, is significant. This measurement of length is the entire scrotal contents, which includes the mass of epididymis at the posterior end.

No immature rabbits were captured during the study, for the reason that trapping was suspended in summer. The density of the brush allowed very few sight observations and no small young were seen.

In the first week of May, 1949, after a long period with no new captures, six unmarked rabbits were taken. Comparison of weight and also hind foot and ear measurements to others with a year-capture record showed no significant difference, although only measurements taken in May, 1949, were compared. This seems to show either that the young grow very quickly, or that these were not young, but immigrants. If the latter assumption is accepted, there is reason to suspect a considerable "shuffle" of adult rabbits during the breeding season.

Population size.—During the winter trapping period, unmarked individuals appeared regularly, indicating that the population had not all been marked. By the latter half of March and throughout April, 1949, only previously marked rabbits were caught, although intensive trapping continued. From this evidence it may be postulated that the rabbit population of the area, gradually marked through the autumn and winter, had been completely marked by late March. In May, new individuals appeared, possibly by immigration connected with breeding season activity.

Analyzing the captures made during the spring months, ten individuals were caught either during the month of April, or both before and after. Since it is assumed that all individuals were marked, these ten can be taken as the adult population on the area in April.

To estimate numbers for other times of the year, a curve representing the rate of disappearance of rabbits from the trapping record was constructed. A table of months after first capture was set up and all individual records filled in, then added together for each month. For example, of 34 rabbits marked, 25 were recaptured at least a month after marking, 17 two months later, and so on. Figure 6, A illustrates this curve. The causes of disappearance may have been emigration as well as death, so that this curve must not be taken as a true record of death rate. However, it was felt that the rate of depopulation, regardless of its natural causes, was the important measurement. Besides the uncontrollable factor of inadequate trapping, the seven trap deaths may be reckoned as an unnatural influence. Five of these occurred within two months, the other two at 10 and 13 months, after marking. Therefore the trap deaths exaggerate the steepness of the curve mostly in the first two months.

The curve serves as an approximation of the yearly population cycle, with a peak in late spring when the adult population is augmented by grown young, a rapid die-off during the dry summer and early autumn, (mostly, I presume, of growing young), and a slower death rate during the winter when the rains bring a better food supply of green annual vegetation. We may take the April population as the minimum adult population of the year, just before the first crop of young have reached full size. The minimum point on the curve "A" of Figure 6 is reached about month number eleven, which would be roughly equivalent to April. The population for September, just before the winter rains begin, can be approximated by the following ratio, using the curve values of month eleven and month four, for April and September respectively: $\frac{\text{Sept. pop.}}{\text{April pop.}} = \frac{\text{Month 4 value.}}{\text{Month 11 value}}$, $\frac{\text{Sept. pop.}}{\text{April pop.}} = \frac{13.}{5}$, and Sept. pop. $= \frac{13 \times 10}{5} = 26$.

The population density may be computed, taking the brush area plus a strip of grass 7 feet wide around the edge, since Figure 3 indicates that the grass was effectively used to this distance. This area is 11.5 acres, so $\frac{26}{11.5}$ equals 2.3 rabbits per acre of chaparral-grass mixture, or a range of .44 acres per rabbit in September.

The mortality rates for males and females differ, as shown by the curves "B" and "C" in Figure 6. The rate of disappearance of males was greater during the early months, possibly indicating that males may escape trapping by their habits of wide ranging and possible emigration. A greater susceptibility to "shock disease" may be indicated by the fact that of eight rabbits dying in traps, five were males. No blood tests were made to diagnose possible hypoglycemia, but the shock convulsions resembled those described by Green and

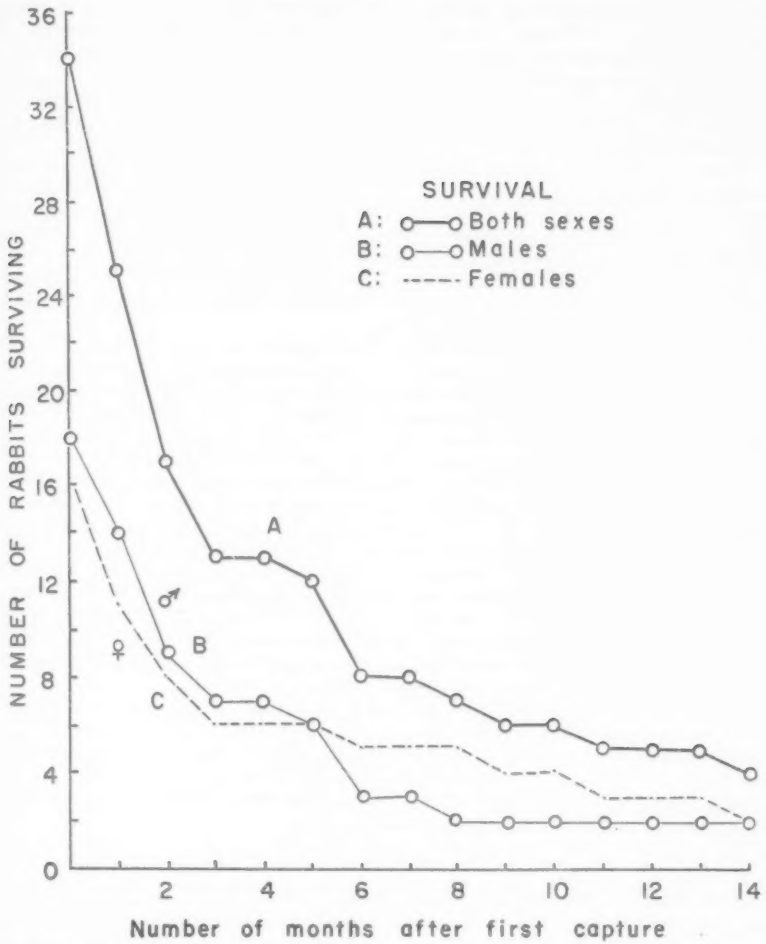

FIG. 6.—Rate of disappearance of marked rabbits from the trapping record throughout the trapping period: A. Both sexes; B. males; C. females.

Larson (1938)—retraction of the head, kicking movements of the legs while the animal lay on its side, extension of the hind legs and almost immediate rigor mortis in this position.

There is some evidence that most of the summer mortality is in the young of the year, since of the seven adult rabbits trapped in April and May of 1948, five were recaptured in September.

Certain individuals lived to a relatively advanced age. During the summer following this study, A. S. Mossman trapped the area and removed four rabbits marked in this study. These, plus one from the original period, yielded the following longevity data for rabbits in the natural environment: three females of ages 2¼, 1¾ and 1 year each; two males of

1½ and 1¼ years each. The two longest-lived females were kept in captivity an additional year, so that their total known life spans were 3¼ and 2¾ years each. In addition, the rabbits were full grown when marked, so that an additional increment of from two to eight months is probable, increasing the longest span to at least 3½ years.

Weight changes.—The weight of each rabbit was taken with a spring balance at every capture. The animals generally remained quiet in a draw-string cloth bag. They were weighed to the nearest ten grams.

Figure 5, B shows the monthly average weights for each sex. After the February onset of the breeding season the weights of males dropped significantly, while the females increased, due perhaps to pregnancy. In both sexes, the heaviest animals were trapped in early fall. The overall average weights were 583 ± 8 grams for males, 637 ± 7 grams for females. This includes 76 male weighings, 101 female.

Some extreme examples of individual variation were noted. Within two days, changes of 65 to 95 grams, in both sexes, were recorded. One female weighed 800 grams in September, 540 in November, 730 in April, and 650 in May.

Parasites.—Ectoparasites were collected at each capture and a blood smear taken from the ear. The blood slides were examined by Dr. Betty Davis and were found to contain no parasitic organisms. The ectoparasites consisted of fleas in the pelage, ticks (usually attached to the skin in the head and neck region), and mites in the ear canal and in the genital region. At present writing the fleas have not been identified; the ticks proved to be *Ixodes* sp. and *Haemophysalis leporis-palustris;* the mites were *Trombicula californica.*

Autopsies of rabbits that died in the traps yielded some endoparasites. In all rabbits, intestinal tapeworms were found as well as nematode stomach worms. No evidence of degeneration or spotting of the liver was noted. In two live individuals, bot fly larvae (*Cuterebra*) were found under the skin in the neck area. In one of these, a female, the larva had matured and dropped out in the trap. This same female had bot larvae twice, in October and again in December; its behaviour was sluggish at these times, but after these infestations it appeared normal for the remaining five months of its capture. A male, caught by A. S. Mossman, a year after this study, had two large bot larvae in the neck region. The individual died four days after capture; since there was much neck bleeding the bots were assumed to be the main contributing cause of death.

Acknowledgements.—In the identification of the ectoparasites, Mr. Douglas Gould and Mr. G. H. Rohrbacker of the Agricultural Experiment Station at the University of California were very helpful; Dr. Betty S. Davis and Dr. Marietta Voge of the Department of Zoology kindly examined the blood smears and parasitic worms, respectively. I am especially indebted to Dr. A. Starker Leopold of the Museum of Vertebrate Zoology for his advice and encouragement throughout the study.

SUMMARY

From March, 1948, to May, 1949, 40 brush rabbits were trapped, marked, and released in a more or less isolated patch of chaparral near the University of California campus, Berkeley. Subsequent movements of the animals were traced by retrapping.

Home ranges of most of the animals centered about 40 feet inside the edge of the brush, but rabbits were trapped throughout the chaparral and the presence of fecal pellets indicated that, at least in winter, the rabbits foraged into the adjoining grassland up to 70 feet from the brush. During the dry season little use was made of grassland; at that time the population seemed to shift deeper into the chaparral. Males moved about more freely than females with the result that the computed average home range for males was 115 feet in radius, and for females, 69 feet. Home ranges of males overlapped, whereas those of females seemed to be discrete with little or no overlap.

By early spring no unmarked rabbits were caught, and it was assumed that the whole population had been marked. Rabbits known to be still living at that time (April) were 10 in number, which constituted a density of 0.9 animals per acre on the 11.5 acre study area. Many animals marked in fall and early winter had disappeared from the population by April. Construction of a curve, based on the rate of population shrinkage, permitted an estimation of the September population at about 2.3 rabbits per acre.

Breeding season, as revealed by testis development in the male, began in February and peaked in April. Yet no immature rabbits were taken in the traps up to early May when trapping was suspended each year. Six unmarked rabbits appeared in the traps in May, but these seemed to be immigrating adults rather than young.

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FOOD HABITS OF FURBEARERS OF THE UPLAND POST OAK REGION IN TEXAS

By John E. Wood

A food habits study is one of the most important single aspects of an ecological study of any animal or group of animals. A close interrelationship exists between an animal and other species of the biota as a result of their feeding habits. A knowledge of the foods aids in explaining these interrelationships. It also helps to explain much of the behavior and daily and seasonal movements of the species and gives suggestions for management.

Much of the literature recording the foods eaten by carnivores is based on an analysis of the stomach content or of fecal remains but little is known of the reliability of each. Little is also known of the comparative value of the various sections of the gut in a food analysis.

An analysis can be done on a quantitative and/or qualitative basis. The quantitative method, recorded by weight or volume, designates the items that make up the major part of the food; however, small items occurring frequently might be pushed into the background. If, however, recorded only as frequency of occurrence, these lesser foods may be overemphasized.

The purpose of the present study is to give meaning to the food habit study. The mere fact that an animal eats an item has little meaning in itself. The importance of an item in the annual diet has, in fact, little meaning unless some ecological significance can be attributed to it such as its abundance, its importance in the diet of other species, or the selection of the item in the presence of other foods.

This study also trys to evaluate the various methods employed in food habit studies; to compare the reliability of a measured value with the visual estimated value in common use; to determine the results of an analysis based on scats and one based on digestive tract contents when both were collected in the same area during the same period; and to evaluate the relative importance of the sections of the gut as a quantitative and qualitative indicator of foods eaten.

The study is based on material collected over a two-year period (January 1950–January 1952) in the uplands of the Post Oak Woods of eastern Texas. The contents of both scats and digestive tracts were analyzed for raccoons (*Procyon lotor*), opossums (*Didelphis marsupialis*), gray foxes (*Urocyon cinereoargenteus*), striped skunks (*Mephitis mephitis*), and ringtails (*Bassariscus astutus*).

The area studied can best be described as an ecotone between the eastern deciduous forest and the tall grass prairie. Bailey (1905) referred to it as the Austroriparian Division of the Lower Austral Life Zone, and Blair (1950) classified it as part of the Texan Biotic Province. It is represented by a rather open stunted forest dominated by post oak and black jack oak. The understory of the climax is a scattered complex of yaupon, deciduous holly, parsley haw, French mulberry, and huckleberry which becomes greatly intensified under heavy grazing. Open areas that are heavily grazed produce an abundance of persimmon, grape, hackberry, dewberry, deciduous holly, yaupon, and several other less

important fruit-bearing trees or shrubs. The abundance and fluctuation of the food supply are discussed later (see Raccoon).

TECHNIQUES AND PROCEDURE

In the discussion of the items eaten, the relative abundance scale used by Quick (1951) is employed. It records prey animals as scarce, rare, common, abundant, or very abundant.

Fecal droppings were gathered, but only those scats that could be identified were taken. Odor was found to be useful in distinguishing scats. Fox scats possess a characteristic odor, a strong musty "fox" odor. This odor is prevalent in areas where foxes are trapped; even preserved digestive tracts possess this scent. Opossums generally have foul smelling scats, whereas those of raccoons have relatively little odor. The size of the particles, almost pulverized in the scats of opposums, aids in distinguishing them from those of the raccoon. The place of defecation is often a clue. Seton (1926) writes of the raccoon, "Its dung is dropped anywhere, at any time, except while in the nest . . . is, in fact, a peripatetic defecator . . . ." The author found raccoon scats along trails; however, it is believed they prefer to defecate upon some elevated object if such can be found. Many raccoon scats were taken from the limbs of large trees as high as 40 feet from the ground. They apparently use the same toilet they, or one of their kind, have previously used, until large piles accumulate. The kind of scat could often be determined by noting the hairs clinging to its outer surface.

Each section of the tract (stomach, small intestine, and colon) was analyzed separately, and all analyses were done on air dry material. A visual estimate of the percentage volume of each group of items was recorded, after which, the volume was recorded in cubic centimeters by placing the items in a graduated cylinder and tamping them gently with a plunger. The three sections of the gut were compared with each other to determine their relative importance as an indicator of food and then combined into one unit for comparison with the scat.

The fecal remains were analyzed as described above but the only records kept were a list of the food items, the total weight of the combined items, and a visual estimate of the percentage volume of each item.

A statistical analysis was used to determine the error of estimated volume. The formulas for the comparison of individuals were used with the actual percentage volume and the estimated percentage volume for each species. This gives a standard deviation of 6.23 for the raccoon, 5.65 for the striped skunk, 4.97 for the opossum, and 11.64 for the gray fox. The first three being very close, a check was made to determine if the difference was real or due to the different-sized samples. The "*t*" test was not significant, indicating they were of the same population and the difference was due to sample size. They were then figured as one sample giving a standard deviation of 5.51. The comparison of the fox with the other species gave a highly significant "*t*" indicating there was a real difference in estimates and the difference was not due to sample size.

The explanation of the larger standard deviation of the fox estimates (11.64) as compared with the smaller estimates of the other species (5.51) is that the bulky foods that made up a large part of the diet for the raccoon, skunk, and opposum can be estimated more accurately than can hair, which comprised the larger part of the remains in the gut of foxes.

RACCOON

Fifty-three digestive tracts and 164 fecal droppings form the basis of this study. Forty-seven of the digestive tracts contained food items in sufficient quantity, in one or more sections of the gut, to permit their use in the analysis.

The discussion of the annual food, for this species, includes the abundance rating of the food item. These ratings are not repeated when discussing the foods of the species which follow.

At least 68 different types of foods were present in the annual diet of raccoons. They in-

clude 11 mammals; 7 birds; 3 snakes; 2 lizards; 22 plants; 14 Families of insects; 1 or more species of frogs, fish, snails, centipedes, mussels, crayfish, pill bugs; and some unidentifiable material.

Of these 68 types, 36 were present in the digestive tract; 47 were in the feces. The number of items recorded in the fecal analysis would be increased had not all insects been grouped into one category. The items found in the scats but not present in the digestive tracts include 9 species of mammals, 2 of birds, 2 of snakes, 12 of plants, and 1 each of terrestrial snail, millipede, fresh-water mussel, pill bug, and unidentified animal. Only nine items, exclusive of insects, found in the digestive tracts were not represented in the scats. They include 3 species of birds, 1 of snake, 2 of lizards, 1 of fish, and 2 of plants. In no case did any constitute more than about three per cent, and most were less than one per cent, of the total annual volume.

The frequency of occurrence, as previously discussed, may give an exaggerated estimate of the number of times a type of food is eaten, but the similar volumetric readings recorded for scats and digestive tracts and the presence of 31 different items found in the scats that were not found in the digestive tracts suggest strongly that scat analyses are a more nearly reliable basis for food studies than analyses of digestive tracts. Hamilton (1951) states, "Droppings do not give as good an index to the foods as do stomach contents, since some foods are so thoroughly digested (earthworms, slugs) that the items do not appear in the fecal remains or are so fragmentary that identification is impossible." Soft bodied animals such as fly larvae and caterpillars were found in the colon and scats. Many items were fragmentary, but identification to Family, or at least to Class, was usually possible. It is likely, however, that the examples cited above by Hamilton would be digested beyond the point of recognition. On several occasions, snail shells were the sole complement of the scats but no material was present that could be identified as the body of the snail.

The colon seems to be the most reliable section of the gut of raccoons when the relative importance of various portions is considered in a food study. Of the 36 items recorded from the entire digestive tract, 31 were found in the colon, 21 in the stomach, and 12 in the small intestine. Eight different items taken from the stomach were present as traces while only seven trace items were recorded for the colon. In only three instances was the percentage by volume appreciably higher in the stomach than in the colon. In one instance, the reverse was true. In no cases were items recorded for the small intestine that were not recorded in one of the other two sections.

These data indicate that it is advisable to analyze the content of the colon as well as the stomach of raccoons; however, if only one section is to be used, the colon is preferable.

A summary, by major groupings, of the foods eaten (Table 1) shows that plant food made up over 50 per cent of the annual diet. Insects were second in importance followed in descending order by mammals, invertebrates other than insects, cold-blooded vertebrates, and birds. The following discussion is an account of the species eaten and their relative importance both in the biota and as food for raccoons.

Mammals ranked third in importance as a food item. Dearborn (1932) found small mammals to hold fifth place in the diet of the Michigan raccoon, while Martin, Zim and Nelson (1951) reported no mammals in the analysis of East Texas specimens.

Cottontails were taken much more commonly than any of the other mammals, occurring in 11.9 per cent of the digestive tracts and 5.4 per cent of the scats. They constituted 10.5 per cent of the total annual volume of food recorded for the digestive tracts and 3.0 per cent for the scats—an average of 6.75 per cent of the annual food. Cottontails were "abundant" in this area. Their vulnerability was increased because of grazing pressure and drought, both of which severely hampered the development of ground cover.

Cotton rats occurred in 5.4 per cent of the scats but constituted only 1.8 per cent of the total annual volume of food. They were "abundant" to "common" in the area but were made vulnerable to predators by the lack of cover. J. M. Inglis of the Department of Wildlife Management, A & M College of Texas, conducting a study on cotton rats, stated their populations decrease with the dying back of blue stem grasses.

Fox squirrels, white-footed mice, pocket mice, Florida wood rats, harvest mice, and pocket gophers were all taken in small numbers (less than 1.0 per cent). Most of them were "common" to "abundant," but were less vulnerable to predation because of their habits.

Armadillos, occurring as trace items in the scats, can probably be regarded as carrion. They were "abundant" or "very abundant," so, if they were natural prey, they would likely have been taken more frequently than indicated in this study.

Deer carrion was less than 1.0 per cent of the annual volume of food. Deer were "abundant" to "very abundant" in the area and numerous dead animals were observed. "Coon signs" were often observed around these carcasses.

Birds were the least important of the larger groupings of food items. They were "very abundant" in the area but only five species (cardinal, Brewer's blackbird, song sparrow, meadow lark, and a gallinaceous bird) and two unidentified groups were represented. Collectively they accounted for less than 1.0 per cent of the annual diet. Dearborn (1932) ranks birds in a similar position in the diet of Michigan raccoons.

Reptiles, amphibians, and fish ranked fifth (or next to last) in importance as food. This agrees with Dearborn's (*ibid.*) findings in Michigan.

Snakes eaten included copperheads, water snakes, and an unidentified species. Collectively they accounted for slightly less than 1.0 per cent of the annual volume of food. Snakes, in general, were "common" to "abundant" in this area.

Frogs occurred in 4.2 per cent of the digestive tracts and 0.6 per cent of the scats. They made up less than 1.0 per cent of the annual volume consumed. They were "fairly abundant" in late winter and early spring but at other times were "rare" in upland areas.

Lizards, especially skinks and fence lizards, were recorded but were insignificant in the annual food. Both of these lizards, however, were "very abundant" in the woodland areas. Minnows were "common" in local areas but were recorded only as trace items.

Insects rated second in importance in the annual food of the raccoon. The Family Locustidae was the only Family, of the 14 represented, of any great importance. Grasshoppers were found in 73.8 per cent of the digestive tracts and represented 27.2 per cent of their volume. They were "very abundant" during the warmer months and "common" to "rare" during the colder periods.

Invertebrates other than insects rated fourth in relative importance as an annual food. Crayfish were found in 9.5 per cent of the digestive tracts and 11.5 per cent of the scats, constituting approximately 2.8 per cent of the annual diet. Dearborn (*loc. cit.*) found they represented 58.9 per cent of the diet of Michigan raccoons. Crayfish were "rare" to "scarce" in the upland areas, but in localized areas where water was permanent, they were "abundant".

Small terrestrial snails were not found in the digestive tracts but were present in 10.3 per cent of the scats and comprised 2.6 per cent of the annual food. Their abundance cannot be stated for they were rarely observed. Empty snail shells were frequently seen in runways and near nests of rodents, indicating their population was fairly high.

Millipedes and sow bugs were eaten but were unimportant in the diet. They were "abundant" under nearly every object large enough to provide a suitable niche.

Plants (the fruits except in grasses) were the most important raccoon food. The 19 species eaten represented 55.4 per cent of the annual volume consumed. Acorns ranked first as a food item. They occurred in 57.4 per cent of the digestive tracts and 32.3 per cent of the scats. Bailey (1926) wrote that the raccoons in North Dakota fatten on acorns in the fall and ". . . the northern limits of their range are almost coincident with the northern limits of the oaks." Martin, Zim and Nelson (1951) found acorns comprised 25–50 per cent of the food of East Texas raccoons. The abundance of this mast crop varies yearly as will be discussed later; however, oak trees (black jack oak and post oak) were "very abundant" throughout the uplands.

Fruits of yaupon, deciduous holly, hackberry, and grape each represented more than 5.0 but less than 10 per cent of the annual volume of food. They were "abundant", with the first two (yaupon and deciduous holly) being "very abundant".

Other plants eaten represented less than 4.0 per cent by volume of the annual diet. They include blackberry, plum, grass, stretch briar, mesquite, persimmon, coralberry, legume, pepper vine, berchemia, and bumelia. They were less abundant or had a limited fruiting period.

Cultivated crops (corn and watermelons) were taken as food. Bailey (1931) stated that raccoons were fond of watermelons. In this analysis, they occurred in only 2.1 per cent of the digestive tracts and constituted less than 1.0 per cent of their volume. Watermelons were "common" in the area in summer. Corn was "common", but was not found in the digestive tracts. It occurred in 1.2 per cent of the scats, representing 1.1 per cent of the volume.

A seasonal analysis of the major foods shows plants to be the most important food during all seasons of the year. In summer, spring, and fall insects were second in importance. Mammals and invertebrates other than insects were more important in winter, spring, and fall than in summer.

Analyses of scats showed different feeding trends for the two winters. The winter of 1949–50 followed a year of abundant rainfall and mild temperatures. The second winter, 1950–51, was preceded by a drought year and had severe, low temperatures during the latter half of the season.

Oak mast was very abundant during the first winter of the study. There was also an abundant supply of fruits of persimmon, yaupon, deciduous holly, French mulberry and coralberry. Small mammal populations were larger than in any other period of the study.

The acorn crop was low during the second winter. Few fruits were produced by the persimmon, French mulberry, yaupon, and coralberry. A fairly large crop of hackberry and deciduous holly fruits was available however. The number of small mammals had decreased, but, as discussed earlier, they were more vulnerable because of the decreasing amount of grass cover.

The feeding trend indicated by the scat analyses for the two winters is summarized in Table 2. The plant foods of the first winter, despite the variety and abundance of fruits present, consisted almost entirely of acorns. Yaupon and deciduous holly, the only other fruits eaten, were represented as traces.

The mammalian food of the first winter consisted of cottontails, 16.6 per cent, and pocket mice, 3.8 per cent. Harvest mice and unidentified rodents were present as trace items.

The percentage volume of food items in the scats of the second winter differed from those of the first. Fruits were less important and animal foods more important. Acorns represented 16.8 per cent of the volume; yaupon and deciduous holly, 15.6; hackberry, 17.4; corn, 3.2; persimmon, 1.7; unidentified fruit, less than 1.0; and coral bead, trace.

Invertebrates were much more important the second winter than the first, even though no apparent change in their abundance was noted.

Mammal remains recorded in the scats of the second winter included wood rats, 2.4 per cent; pocket gophers, 3.0; cotton rats, 3.1; white-footed mice, 1.0; and fox squirrels, less than 1.0.

TABLE 1.—*Volume percentage of annual food*

FOOD	RACCOON	OPOSSUM	GRAY FOX	RINGTAIL	STRIPED SKUNK
Mammal	9.1	14.9	77.7	42.7	2.4
Bird	0.4	3.8	9.5	19.3	31.1
Cold-blooded vertebrates	1.3	7.4	tr	tr	tr
Insects	26.5	25.0	4.1	6.9	65.2
Other invertebrates	5.5	tr	—	2.2	—
Plants	55.4	44.8	7.8	27.9	tr
Unidentified	1.5	3.2	tr	tr	—

TABLE 2.—*Percentage volume of food items in 164 raccoon scats showing the variation in diet between two winters*

FOOD	WINTER 1949-50	WINTER 1950-51
Fruits	70.5	55.0
Mammals	20.4	9.9
Insects	4.4	5.3
Invertebrates other than insects	—	27.4
Birds	tr	1.1
Unidentified	4.4	0.3
Total	99.7	99.0

All food items eaten during the two winters were "abundant" during the first winter. Many of these foods were ignored the first winter when the oak mast was abundant, but they were utilized the second winter when the oak mast crop was lean. It appears from these data that the raccoons have selective feeding, at least under optimum conditions, and acorns are a preferred food.

Baker, Newman, and Wilke (1945) studied the food habits of raccoons in the bottomlands of eastern Texas. They reported that acorns comprised 61 per cent of the total volume of winter foods. Other foods reported in descending order were persimmons, crayfish, caterpillars, passerine birds, grasshoppers, and spiders.

OPOSSUM

Twenty-five digestive tracts and 23 fecal droppings were collected and analyzed. Thirty-nine different foods were included in the analysis—4 species of mammals, 5 of birds, 3 of snakes, 2 of lizards, 2 of fish, 10 of plants, 1 of toads, and several kinds of insects, spiders, millipedes, snails, and unidentified items.

The digestive tracts contained 36 of the 39 food items, 26 more than were recorded in the scats. This suggests that digestive tracts of opossums are a more reliable source of data than fecal droppings as a basis for food studies.

Thirty-one foods were recorded in the stomach, 11 in the small intestine, and 20 in the colon. The stomach, as compared with the other sections of the gut, had a larger number of different food items and a lower percentage of trace items. The colon contained only three items which were absent in the stomach, all recorded as traces. All food items in the small intestine were also found in one or both of the other sections. These data support the findings of Taube (1947) that stomach analyses afford a more accurate indication of food habits of the opossum than do analyses of intestinal contents or fecal matter alone.

A summary of the major food items of the annual diet (Table 1) in order of their importance were plants (mainly fruits and grasses), insects, mammals, cold-blooded vertebrates, birds and invertebrates other than insects. Plants represented 64.6 per cent of the volume of the scats and 25 per cent of the volume of the digestive tracts, or an average of 44.8 per cent by volume of the annual food.

Four species of mammals were present in the diet including the white-footed mouse, cottontail, cotton rat, and opposum. Cottontails were taken frequently and were present in 12 per cent of the digestive tracts and 4.3 per cent of the scats. They constituted 5.3 per cent of the volume of the tracts and 4.3 per cent of the volume of the scats. White-footed mice represented 4.1 per cent of the annual food. Cotton rats, not found in the fecal remains, occurred in 8.0 per cent of the digestive tracts, representing 3.8 per cent of the volume of food. Young opossums made up 1.6 per cent of the annual volume of food. This suggests a cannibalistic trait in the opossum, but since opossum carrion is known to be eaten, it is possible that all of these records represent carrion. The author found that in captivity, young opossums killed their mother, an observation also reported by Raven (1929). Raven

did not state that they fed on her carcass, but they did in this study. Raven also records that a female being sent to him ate her young.

Birds, which are next to the last in importance as a major item of food, were not recorded in the scats, and represented only 3.8 per cent of the annual volume of food. They included, in order of importance, yellow-bellied sapsucker, mourning dove, spotted towhee, chicken, and unidentified bird.

Snakes utilized as food included the southern ground snake, ribbon snake, and copperhead. The first two represented less than 1.0 per cent, but copperheads represented 5.7 per cent of the diet. These snakes may have been carrion but no signs were present to indicate it. Lewis (1929) placed a black snake (3′, 8″) in a cage with an opossum. With one snap of its jaws, the opossum broke the snake's neck and then ate it. Opossums may handle copperheads in a similar manner.

Lizards (skinks and fence lizards) and fish (minnows and sun fish) were present only as traces. Toads (species undetermined) represented 1.0 per cent of the volume of the annual food.

Insects, second in importance as a food, occurred in 88 per cent of the digestive tracts, 69.5 per cent of the scats and averaged 25 per cent of the annual volume of food. Most insects were so thoroughly masticated that it was impractical to separate them into families.

Spiders, millipedes, and terrestrial snails were eaten, but, collectively, they represented less than 1.0 per cent of the annual volume consumed.

Plant foods included nine species and two unidentified groups. Acorns represented 31.4 per cent of the volume of the annual diet. Persimmons, recorded only in scats, constituted 6.0 per cent of the diet. Pears and blackberries, found only in the digestive tracts, represented 4.1 and 2.3 per cent, respectively, of the total volume. Other plants accounted for less than 1.0 per cent of the annual food. They included French mulberry, grass, watermelon, grape, hackberry, and unidentified plants.

GRAY FOX

Sixteen digestive tracts and 18 fecal droppings were analyzed, yielding 22 different foods. These included 6 species of mammals, 6 of birds and their eggs, 4 of plants, 3 of insects, 1 lizard, and 1 unidentified plant.

The digestive tracts contained 15 of the 22 items and the fecal remains, 16. Trace items were abundant in neither. It is suggestive that a scat analysis is as reliable as one based on digestive tracts. The stomach contained 13 of the 15 items; the small intestine, 11; and the colon only 4.

The percentage frequency of occurrence of food items was consistently higher in the small intestine than in the stomach but the percentage of volume was about equal. Two items were recorded in the stomach that were not found in the small intestine; and in one instance, the reverse was true. These data suggest that either the stomach or the small intestine can be used successfully to determine the food of the gray fox. It is suggested, however, that both sections be used in any analysis. Often an animal is found with nothing but trap debris in the stomach, but with relatively large amounts of food remains in the small intestine.

A summary of the major grouping of foods (Table 1) shows small mammals were the most important food of this species. The items in order of their importance were mammals, birds, plants, and insects.

Six species of mammals were recorded—white-footed mice, Florida wood rats, cottontails, cotton rats, pocket mice, and harvest mice. Cottontails, the most important, were found in 69 per cent of the digestive tracts and 33 per cent of the scats, forming 42 per cent of the total volume. Cotton rats were second, appearing in 31 per cent of the digestive tracts and 44 per cent of the scats, and accounting for 28 per cent of the volume. Other mammals were of minor importance.

Robins represented about 3 per cent of the annual food and spotted towhees represented little more than a trace. Mourning doves and unidentified passerine birds were present in 11 per cent of the scats and accounted for about 3 per cent each of the total volume of food.

Chicken eggs were recorded in the scats as trace items. An unidentified lizard occurred as a trace. Insects were relatively unimportant in the diet and comprised only about 4 per cent of the total volume.

Persimmons were the most important plant food. They were present in 11 per cent of the scats and about 12 per cent of the digestive tracts, accounting for 6 per cent of the total volume. Yaupon and deciduous holly berries, acorns, and grasses were recovered in small quantities.

STRIPED SKUNK

Eighteen digestive tracts and three scats were analyzed yielding 27 different foods. They included 1 species of mammal, 2 of birds, 1 snake, 20 Families of insects, 1 millipede, and 1 plant. An insufficient number of scats was examined to make a statement of their relative value in a food habits analysis.

Of 26 items recorded for the entire gut, 17 were found in the stomach, 19 in the colon, and 14 in the small intestine. Three items were recorded for the stomach that were found in no other section, three such items were recorded for the small intestine, and two for the colon. The volume and weight percentages and frequency of occurrence were nearly equal for items occurring in more than one section. These data suggest that any one section of the gut is a fairly accurate indicator of the foods eaten. It is recommended, however, that the entire digestive tract be used for a trapped animal is still usable even though one or more sections of the gut are filled with trap debris.

A summary of the major food groups (Table 1) shows that insects were the most important food, birds were second in importance, mammals (cottontails only) represented about two per cent of the annual diet, and plants (persimmons only) less than one.

Brewer's blackbird and an unidentified species were the only birds represented in the analysis. An unidentified snake was recorded as a trace item. Grasshoppers accounted for about one-half of the total volume of insects eaten.

Davis (ms.) recorded the seasonal food of the striped skunk in Texas as—Fall: insects 76 per cent, arachnids 24; Winter: insects 52 per cent, arachnids 5, reptiles about 2, small mammals 18, vegetable matter 22, with birds and millipedes making up the balance; Spring: insects 96 per cent, reptiles about 2, small mammals 2, vegetation and small birds the balance; Summer: insects 88 per cent, arachnids 4, reptiles 1.5, small birds 3.5, and centipedes, small mammals, and vegetation the balance.

RINGTAIL

Ten digestive tracts, all taken in winter, and 19 scats form the basis of this study. Eleven of the scats were taken in winter, five in spring, and three in autumn. Only small quantities of food were found in any digestive tract and this was analyzed as a unit: consequently, no comparative values can be given for the various sections of the gut.

Table 1 records a summary of the major groups of food. Small mammals formed the largest part of the diet, representing 62 per cent of the volume of items taken from the digestive tracts and 23 per cent of that in the scats. Fruits represented 28 per cent of the volume of foods in the digestive tracts and 28 per cent of that in the scats. Small birds were third in importance being about 7 per cent of the total volume of food items in the digestive tracts and 32 per cent of the volume of the scats. In descending order of importance were insects, invertebrates other than insects, and cold-blooded vertebrates.

Three species of mammals were present in the diet, namely the cotton rat, cottontail, and white-footed mouse. Cotton rats were the most important of the three and represented about half of the volume of the items found in the digestive tracts, and about 19 per cent of those found in the scats. Cottontails were not found in the scats but they comprised about 9 per cent of the volume of items in the digestive tracts. White-footed mice occurred as about 4 per cent of the total volume of scats and a little more than 2 per cent of the total volume of food recorded in the gut.

Five species of birds and one unidentified group were utilized as food. The approximate

average percentage volume of those found in the scats and digestive tracts were cardinal, 11; flicker, 3; robin, 3; unidentified bird, 3; and cowbird and meadowlark, trace.

One scat contained trace remains of a southern ground snake, the only reptile recorded.

Insects occurred in both the digestive tracts and the scats. An average of the two reveals that insects represented about 7 per cent of the annual volume of food. Millipedes, spiders, and crayfish were found in small quantities.

Eight species of plants were recorded. Approximate averages of the volumes of those found both in the scats and the digestive tracts are as follows: yaupon berries, 10 per cent; acorns, 8; hackberries, 5; honey locust, 3; French mulberries, 3; persimmons, coralbeads, and grasses, trace.

Davis (ms.) recorded the stomach content of 100 ringtails from central Texas as follows: passerine birds, 9.9 per cent; small mammals, 24.4; snakes and lizards, 3.9; toads and frogs, 0.2; insects, 31.2; spiders, scorpions, and centipedes, 11.1; and fruits of persimmon, hackberry, and mistletoe, 19.3. Martin, Zim, and Nelson (1951) stated that in Texas, persimmons accounted for 5 to 10 per cent of the summer and fall foods; red cedar for 5 to 10 per cent of the winter and spring foods; hackberry, 2 to 5 per cent of the fall, winter and spring foods; mistletoe, 2 to 5 per cent of the winter diet; and prickly pear, barberry, buckthorn, sophora, mesquite, grape, oak, plum, and ground cherry for ½ to 2 per cent of the diet.

SUMMARY

This study includes an analysis of the contents of digestive tracts and scats for raccoons, opossums, gray foxes, striped skunks, and ringtails.

For the raccoon, an analysis based on scats was found to be as reliable as one based on digestive tract contents. It is suggested, however, that when the digestive tract is used for an analysis, the colon as well as the stomach contents be included in the study.

The stomach of the opossum was found to be the most reliable section of the gut upon which to base an analysis and the content of the stomach is a more reliable indicator of foods eaten than are the scats.

For the gray fox, the analysis indicated that scats give as reliable an indication of foods eaten as do the digestive tract contents. These data suggest that either the stomach or the small intestine is satisfactory for analyses but it is suggested that both be included in a study. More error was encountered in visual estimates of the volumes of fox foods than was encountered in estimating the foods of the other animals in this study.

Each section of the gut was found to be equally reliable in the striped skunk. It is suggested, however, that the entire gut be included in an analysis.

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ON *CEBUS APELLA* (LINNAEUS), WITH A NOTE ON *CEBUS CAPUCINUS* (LINNAEUS)

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In a recent paper on the monkeys of Colombia, Hershkovitz (1949) has stated, that *Cebus apella* Linnaeus, 1758, is a member of the "crested" group of *Cebus*—namely, that it has hair crests on either side of the head, together with other anatomical attributes of the crested group of *Cebus*. His personal concept of what *Cebus apella* looks like is shown in his figure (52, e., f., p. 325). In addition, he makes the geographical range of *apella* Matto Grosso.

Some years ago (Tate, 1939), when discussing the status of some species of the genus *Cebus*, I concluded on the basis of evidence presented beyond that *C. apella* was an uncrested species and that the name appeared to be applicable to the common gray-brown species inhabiting the Guiana region, which Hershkovitz (p. 332) refers to *C. nigrivittatus castaneus*.

Hershkovitz (1949, p. 332) suggests that I should have "rejected" *apella*—in other words, treated it as unidentifiable. If such rejection were proper, it would also be proper to throw out many other currently accepted Linnaean names as well as others by older authors, based upon text and plates. It will be demonstrated beyond, first that *apella* is an uncrested species and, second, that its systematic history (Linnaeus, 1754, 1758) is precisely like that of the accepted *capucinus*, the designated genotype of the genus *Cebus*.

The basis in nomenclature for *Cebus apella* is *Simia apella* Linnaeus, briefly described in the 10th edition of the Systema Naturae . . ., 1758, p. 28. That description is cited in full below:

> "S[imia] caudata imberbis, cauda subprehensili, corpore fusco, pedibus nigris. . . . Habitat in America. Undique circumspiciens, Sono pulli Meleagridis famelici."

This description is accompanied by a single reference—a reference to one of Linnaeus' own works: Mus[eum] Ad[olphi] Fr[iderici], p. 1, pl. 1 [1754] and is a condensation of the much more extended and excellently illustrated description contained in that work. By again using his own name and by condensing his own earlier description, Linnaeus unquestionably "accepted" his own name

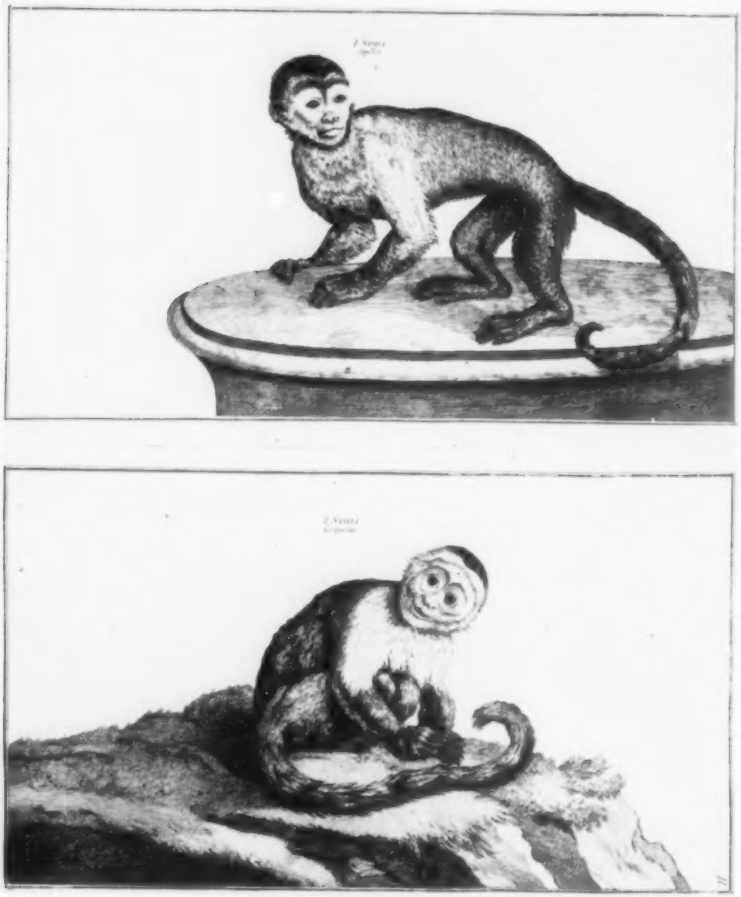

PLATE I

UPPER: *Simia apella* of Linnaeus (1754). LOWER: *Simia capucina* from same source.

apella of 1754. Thus, although the date of actual *publication* of the name *apella* Linnaeus is 1758, the *description* and the *identity* of the species *apella* are derived from one of Linnaeus' earlier works (1754, p. 1, plate 1). The said work is a splendid folio dealing with the collections of plants, animals and minerals contained in the collection of the King of Sweden. It contains extended descriptions in parallel columns in Latin and Swedish and is illustrated by large, finely prepared plates which include both *Simia apella* and *Simia capucina*. It is the *only* reference given by Linnaeus in 1758 under *Simia apella* and *Simia capucina*.

The part of the text of this important work relating to *apella* follows:

"Apella. Simia imberbis, cauda prehensili, pedibus nigris, corpore fusco. Viva asservaturitidem in Museo. Corpus magnitudine Felis, colore fuscum, s. e. griseo nigricans uti Martes; at Pedes et Cauda nigra. Caput supra nigrum, nigredine ad angulum frontis extensa. Facies incarnato-fusca, a superciliis ad mentum usque nuda. Supra supercilia facies quasi rasa pilis nuper renatis. Sub mento vellus breve, densum, atrum, pingue. Aures rotundatae, parvae. Cauda longitudine corporis, basin versus crassior, pilis brevibus vestita, semper incurva, qua dum scandit, prehendit animal. Scandit facillime, semper in motu versatur, et aliqua gesticulatione sese delectat, undique circumspicit, continue se scalpit et purgat; Museas obvolitantes manu capit et edit. Sonus ipsi famelici pulli Meleagridis. Non facile salit e ramo in ramum. Pulvere tabaci lubenter adspergitur in tergo."

Translation:

"A beardless monkey with prehensile tail, black feet, fuscous body. It was brought alive to the museum. Body size that of a cat, color fuscous, and grayish black like Martes; feet and tail black. Head black above, the black extending to the angle of the forehead. Face flesh-fuscous, from the brows to the chin almost bare. Above the brows the face almost smooth, with hairs like a newborn. Under the chin is short down, dense, black and greasy. Ears rounded, small. Tail the length of the body, stouter towards the base, clothed with short hairs, always incurved, with which when it climbs the animal takes hold. It climbs easily, often turns about in motion, and delights in various gestures, it looks about in all directions, continually scratches and cleans itself; it catches with its hand and eats the flies flying about. Its voice is like that of a hungry turkey chick. It does not easily jump from branch to branch. It likes to scatter tobacco dust on its back."

This ample if discursive description is illustrated (1754, plate 1) by a wholly crestless *Cebus* monkey, which I reproduce herewith (Pl. I). Comparison of this picture with the *apella* of Hershkovitz (1949, p. 325, fig. 52) will, I think, forever still any doubt that Linnaeus had before him an uncrested *Cebus* monkey when he described *Simia apella*.

With regard to the range and type locality of *apella*, I contend that the brown Guiana *Cebus* resembles Linnaeus' plate of *apella* fully as closely as the Central American white-faced *Cebus* resembles his plate of *capucinus*. If this point is conceded, there can be no objection to the restriction of the type locality of *apella* to Guiana.

Cebus capucinus (Linnaeus), concerning the identity of which there appears never to have been doubt, passed through precisely the same taxonomic history as *Cebus apella*. It was described at length and figured (plate 2) in the same volume (1754), and in 1758 it was "adopted" by its author by inclusion as a condensed diagnosis in the Systema Naturae, 10th edition, p. 29. A photographic reproduction of the original plate of *capucinus* is also shown herewith (Pl. I).

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STATUS OF THE BLACK-FOOTED FERRET

BY VICTOR H. CAHALANE

The black-footed ferret (*Mustela nigripes*) is one of the rarest of North American mammals. Comparatively few records of its occurrence have been published, and information regarding its whereabouts has been difficult to obtain. As it is reputed to be dependent on prairie dogs (*Cynomys* sp.) for food, if not also for shelter, the widespread poisoning of these rodents has aroused fears that the ferret will soon become extinct.

This problem was discussed by the Executive Committee of The American Committee for International Wild Life Protection at its meeting in New York City in December, 1952. It was agreed that the apparent plight of the ferret warranted an investigation to determine the facts on which action could be taken. The writer was requested to canvass those agencies of the Federal Government that would be most likely to have information on the present numbers and distribution of the species.

An official of each agency was asked to circularize those field employees who might be able to contribute data. Numerous reports were forthcoming. Thanks are hereby expressed for generous assistance and records from the Fish and Wildlife Service (particularly Dr. Clarence Cottam), Soil Conservation Service (especially Mr. Lawrence V. Compton), and the National Park Service. The Bureau of Land Management and Bureau of Indian Affairs also cooperated in the survey but were unable to contribute reports of ferrets, if any, on lands under their administration.

State agencies such as game and fish departments were not circularized, although in numerous instances employees were queried by representatives of the Federal bureaus mentioned. This resulted in several records of ferrets. Undoubtedly, additional reports would have been acquired if it had been feasible to extend the inquiry to officials of States, as well as Canadian Provinces, within the animal's reputed range. It was felt, however, that sufficient information for the purpose could be gained by limiting the survey.

The large number of reports received were sifted for timeliness and reliability. Forty-two were considered to be sufficiently recent and authentic, and were summarized as follows:

Nebraska. Report No. 1.—A ferret was found drowned in a drainage ditch at a fish hatchery during the winter of 1951–52 at Las Animas, Bent County. Reported by Joseph L. Gray, Colorado Game and Fish Department; recorded March 2, 1953, by Jack D. Remington of same agency.

Report No. 2.—A ferret was seen in a prairie dog town (date unknown) near Mancos, Montezuma County. Reported by Donald Spencer, Fish and Wildlife Service; recorded February 17, 1953, by E. R. Kalmbach of same agency.

Report No. 3.—A ferret was found killed on a highway September 17, 1952, 5 miles east of Dearfield, Weld County. Sex was not determined. Environment: "wheatfield and grassland; near a riverbottom." Reported by Jack D. Remington, Colorado Game and Fish Department; recorded February 10, 1953, by Lee E. Yeager, Fish and Wildlife Service.

Report No. 4.—A ferret was captured (date unknown) in a prairie dog town near Denver, Jefferson County. The ferret was maintained alive for 5½ years. Reported by Donald Spencer; recorded February 17, 1953, by E. R. Kalmbach.

Montana. Report No. 5.—Two ferrets were seen in 1952, 15 miles northwest of Chinook, Blaine County. Reported by Leo K. Pipal, Soil Conservation Service; recorded June 2, 1953, by M. S. McMurtrey, of same agency.

Report No. 6.—"Four or five" ferrets were seen in 1952 on the north slope of the Bearpaw Mountains, Blaine or Hill County. Reported by Leo K. Pipal; recorded June 2, 1953, by M. S. McMurtrey.

Report No. 7.—Two ferrets were seen in 1952 near Hays, Blaine County. Reported by Leo K. Pipal; recorded June 2, 1953, by M. S. McMurtrey.

Report No. 8.—Three ferrets were seen along a road 3 miles from Chinook, Blaine County; date of observation was not given. Reported by Leo K. Pipal; recorded June 2, 1953, by M. S. McMurtrey.

Report No. 9.—A ferret was found dead August 3, 1948, on a road near Lavinia, Golden Valley County. Reporter not identified; recorded February 17, 1953, by James T. McBroom, Fish and Wildlife Service.

Report No. 10.—A ferret was shot March 6, 1949, in a prairie dog town 10 miles east of Billings, Yellowstone County. Reporter not identified; recorded February 17, 1953, by James T. McBroom.

Report No. 11.—A ferret was seen in the spring of 1948 near Roundup, Musselshell County. Reporter not identified; recorded February 17, 1953, by James T. McBroom.

Report No. 12.—An adult male ferret was found killed November 3, 1953, on a highway north of Alzada, Carter County. Skin and skull were deposited in the U. S. National Museum. Reported by Watson E. Beede, Fish and Wildlife Service; recorded November 21, 1953, by James T. McBroom.

Nebraska. Report No. 13.—A ferret was captured by hand May 6, 1946, in a prairie dog town in the northwestern portion of Banner County. The skin is in the University of Nebraska State Museum. Reported by George Weidman, Nebraska State Game Commission; recorded August, 1953, by Fichter and Jones (Jour. Mamm., 34: 385–388).

Report No. 14.—A ferret was found killed March 16, 1949, on a road south of Overton, Dawson County. Reported by Burman Guyer, Nebraska Game Commission; recorded August, 1953, by same.

Report No. 15.—A ferret was seen in the summer of 1952 at a prairie dog town 20 miles west of Broken Bow, Custer County. Reported by Herbert Thompson, Fish and Wildlife Service; recorded March 14, 1953, by Tom J. Turner of same agency.

Report No. 16.—A ferret was seen during the summer of 1952 while carrying a 13-lined ground squirrel in a prairie dog town 10 miles south of Ansley, Custer County. Reported by Herbert Thompson; recorded March 14, 1953, by Tom J. Turner.

Report No. 17.—"Occasional sight records" of ferrets were made in prairie dog towns in Dawes and Sioux Counties (no date). Reported by an unidentified employee of the Fish and Wildlife Service; recorded February 9, 1953, by Tom J. Turner.

Report No. 18.—A ferret was seen in February, 1953, near a road southwest of Harrisburg,

Banner County. Reported by C. H. Scott, Soil Conservation Service; recorded March 13, 1953, by same.

Report No. 19.—A ferret was seen in the fall of 1952 near a creek in Banner County. Reported by C. H. Scott; recorded March 13, 1953, by same.

New Mexico. Report No. 20.—A ferret was seen during 1950 in a prairie dog town in McKinley County. Reported by Louis H. Laney, Fish and Wildlife Service; recorded February 11, 1953, by same.

North Dakota. Report No. 21.—Two ferrets were seen March 5, 1951, 6½ miles west and 1½ miles south of Mott, Hettinger County. One animal was killed and the specimen is preserved in the North Dakota Historical Society Museum. Reported by R. N. Randall, Fish and Wildlife Service; recorded February 24, 1953, by John L. Sypulski, of same agency.

Report No. 22.—Two young ferrets were killed by a domestic cat in June 1952, 25 miles south of Medora, Billings County. Reported by Bert Boicourt, Medora, North Dakota; recorded April 10, 1953, by Neil J. Reid, National Park Service.

South Dakota. Report No. 23.—Six ferrets were seen during the summer of 1950 in prairie dog towns on the Rosebud Indian Reservation, Todd and Mellette counties. Reported by Walter Stammerjohn, Fish and Wildlife Service; recorded February 12, 1953, by Harold H. Haecker of same agency.

Report No. 24.—Eight ferrets were seen during the summer of 1951 in prairie dog towns on the Pine Ridge Indian Reservation, Shannon and Washabaugh counties. Reported by Ralph Block, Fish and Wildlife Service; recorded February 12, 1953, by Harold H. Haecker.

Report No. 25.—Two ferrets were seen during the summer of 1951 in a prairie dog town in Twp. 15, Range 20, Ziebach County. One animal was killed and is preserved in the U. S. National Museum. Reported by Ralph Block; recorded February 12, 1953, by Harold H. Haecker.

Report No. 26.—"At least 2" ferrets were seen during the summer of 1951 in prairie dog towns on the Rosebud Indian Reservation, Mellette County. Reported by Harvey Gibson, Fish and Wildlife Service; recorded February 12, 1953, by Harold H. Haecker.

Report No. 27.—Six ferrets were seen during the summer of 1952 on the Pine Ridge and Rosebud Indian Reservations. Reported by Harvey Gibson; recorded February 12, 1953, by Harold H. Haecker.

Report No. 28.—Six ferrets were seen during the summer of 1952 in Conata Basin, Pennington County. Reported by George W. Barnes, Fish and Wildlife Service; recorded February 12, 1953, by Harold H. Haecker.

Report No. 29.—Four young ferrets were found, 1952, in a nest in a haystack south of Lemmon, Perkins County. Reported by W. L. Johns, South Dakota State Game Commission; recorded February 12, 1953, by Harold H. Haecker.

Report No. 30.—A ferret was seen in the spring of 1948 near Chamberlain, Brule County. Reporter not identified; recorded February 17, 1953, by James T. McBroom.

Report No. 31.—A ferret was trapped in the fall of 1951 near Mobridge, Walworth County. Reporter not identified; recorded February 17, 1953, by James T. McBroom.

Report No. 32.—A ferret was trapped in 1951 or 1952 at Wessington Springs, Jerauld County. Reported by R. N. Randall; recorded February 24, 1953, by John L. Sypulski.

Report No. 33.—A ferret was shot in November 1951, on Okobojo Creek, Sully County. Reported by J. W. Leete; recorded February 24, 1953, by John L. Sypulski.

Report No. 34.—Two ferrets were trapped during the summer of 1952 in a prairie dog town north of the Cheyenne River in Mead County. Reported by Roy L. Clennon, South Dakota State Game Commission; recorded February 15, 1953, by Oren Bates, Sioux Falls, South Dakota.

Report No. 35.—Two adults and a young ferret were seen about July 1, 1953, in a prairie dog town 11 miles east of Howes, Ziebach County. Reported by Ralph Block; recorded August 6, 1953, by Noble E. Buell, Fish and Wildlife Service.

Report No. 36.—A ferret was seen during the summer of 1953 in a prairie dog town on Bull Creek, Mead County. Reported by Ralph Block; recorded August 6, 1953, by Noble E. Buell.

Report No. 37.—A ferret was seen during the summer of 1952 in a prairie dog town 5 miles northeast of Philip, Haakon County. Reported by W. H. Zimmerman, Soil Conservation Service; recorded May 7, 1953, by M. S. McMurtrey.

Report No. 38.—Six adults were seen during the summer of 1953 in a prairie dog town in Haakon County 2 miles west of Midland. Five of the animals were live-trapped; two died in captivity but two males and a female were released in Wind Cave National Park, Custer County. Reported by George W. Barnes; recorded November 6, 1953, by Warren E. Garst, Douglas, Wyoming (Jour. Mamm., in press, 1954).

Texas. Report No. 39.—A ferret, "3 to 6 weeks old," was captured alive in May, 1953, near Dalhart, Dallam County. Reported by Austin E. Klahn, Soil Conservation Service; recorded June 17, 1953, by Philip F. Allan of same agency.

Utah. Report No. 40.—An adult male was killed (no date) 2 miles south of Blanding, San Juan County, and is preserved in the Museum of Vertebrate Zoology, University of California. Collector not identified; recorded August 10, 1952, by Stephen D. Durrant (Univ. Kansas Publs., Mus. Nat. Hist. 6: 1–549).

Wyoming. Report No. 41.—A ferret was seen in 1948 in Niobrara County. Reported by Carl R. Mueller, Fish and Wildlife Service; recorded February 13, 1953, by same.

Report No. 42.—A ferret was seen in the spring of 1952 near Shawnee, Platte County. Reported by Carl R. Mueller; recorded February 13, 1953, by same.

DISCUSSION

Most of the records fell in the five-year period 1948–1952. One observation in 1946 was accepted, as were six from 1953. (Because inquiries were made early in the year, prior to the usual field season, comparatively few occurrences of ferrets were reported for 1953. Most of these reports were sent in by field agents of the Fish and Wildlife Service who were particularly interested and contributed additional late information.) Four records were accepted which could not be dated accurately, but were believed to have been made since 1946. Another was included because it was published (by Durrant) in 1952, although the date the specimen was taken was not given.

The 42 acceptable reports were made by some 30 persons and involved about 90 black-footed ferrets. In 25 of the 42 cases, lone animals were observed. In the remaining 17 instances, more than one ferret was reported. Two animals were seen at eight localities, three at two localities, four in two localities, and six at four locations. Eight ferrets were seen in another instance. One report stated that animals were seen "occasionally" over a period of time; the number of individuals, although definitely more than one, could not be ascertained.

Some, at least, of the reports citing several ferrets in a restricted locality cannot be ascribed to repeated observations of one individual. For example, the report (No. 37) from two miles west of Midland, Haakon County, South Dakota, which gave a total of six ferrets, was based on five animals captured and removed for purposes of photography, and a sixth animal that remained at large. In some cases, however, it is probable that sight observations were duplicated. Therefore the *apparent* total of about 90 ferrets reported would be reduced somewhat. The *true* number, however, can hardly be less than 50 and may be closer to 60 or even 70.

The reports of ferrets came from ten States (Fig. 1). South Dakota led with 16 records. It was followed by Montana with eight and Nebraska with seven;

FIG. 1.—Recent records of the black-footed ferret (*Mustela nigripes*). Numbers refer to descriptive data in text. Dotted line indicates apparent range of species within the United States as shown by information gathered in survey.

Colorado, four; North Dakota and Wyoming, two each; and Texas, New Mexico and Utah, one each. As the map shows, ferrets apparently are most "numerous" in the area from central and western Nebraska to the southwestern corner of North Dakota. The limits of the range of *Mustela nigripes* in the United States, as shown by the dotted line, is based on the information acquired in the survey. It ignores earlier records, notably in Texas, Kansas, and Oklahoma. (Most of these are 10 to 30 years old. It is entirely possible that the species still persists in these areas, but the absence of reports is not encouraging).

A number of the ferrets reported in the present survey were found dead or were destroyed. Four were killed on roads or highways by motor vehicles. Nine were trapped or shot by man. Two young ferrets were destroyed by a domestic cat. One ferret was found in the drainage ditch of a fish hatchery, apparently the victim of drowning. Two animals died soon after they were captured alive. Another lived in captivity for five and one-half years but was eliminated as far as perpetuation of the species was concerned. A total of 19 ferrets, therefore, are known to have been removed from the breeding potential of this rare species. The certain loss thus approached one-third of the total number of ferrets of which we have record during the period 1946–1953.

Furthermore, many of the ferrets that were not molested directly were living in prairie dog colonies that were being destroyed by poisoning. We do not know whether this carnivore will feed on dead or poison-affected prairie dogs, or the possible effect of secondary poisoning. There is no question, however, that the sudden elimination of the primary source of food (in this instance, prairie dogs) exposes almost any animal to unexpected, serious hazard. If the species is adaptable and other food sources are available, a transition can be effected. If not, the animal must starve or re-establish itself in another environment. The latter is generally a dangerous experiment; in Nature, few vacancies exist.

Information gathered in this survey supports previous impressions, as well as Sioux legends, that the black-footed ferret is closely associated with the prairie dog. In 18 of the 20 reports which described the habitat where the ferrets were seen, the environment was "*prairie dog town.*" Employees of the Fish and Wildlife Service engaged in predator and rodent control, were generally agreed that this is the home of the ferret and that prairie dogs are the main source of food. This opinion was summarized (in memorandum of February 12, 1953; official files of Fish and Wildlife Service) by Mr. Harold H. Haecker, Assistant District Agent, on the basis of 24 years' experience in predator and rodent control work in the Dakotas and Nebraska:

"We have seen [black-footed ferrets] almost always in prairie dog colonies. We have come to believe that they live preferably in such places, and are almost specifically feeders on prairie dogs."

Mr. Haecker explains his qualifying "almost" by pointing out that three times in the past 30 years prairie dogs in South Dakota have been almost completely wiped out by poisoning. Nevertheless, the number of ferrets did not seem to fluctuate markedly throughout the period. "Not many were seen, but always a few. . . . It would seem with such drastic reduction of prairie dogs that black-footed ferrets would entirely disappear if their relationship to the prairie dogs was specific," i.e., if the ferret were completely dependent on the prairie dog and unable to subsist on other prey.

Undoubtedly, ferrets can and do prey on other species than prairie dogs. One of the Nebraska ferrets reported in our survey was seen carrying a thirteen-lined ground squirrel (*Citellus tridecemlineatus*, probably *pallidus*). Nevertheless, it is almost certain that drastic reduction of prairie dogs, as in control programs, must have grave, although perhaps not fatal, consequences for the black-footed ferret population.

Obviously, more factual information on the life history of the ferret is needed. This is a unique opportunity for a biologist to make an original contribution to our present scanty knowledge of a rare American mammal.

In the meanwhile, we believe that complacency regarding the future of the species is not justified. With new poisons and improved methods of using them, extermination of rodents and other unwanted species is now possible on a relatively large scale. Prairie dog "control" is proceeding vigorously, removing an important source of food and, when gas is used, killing ferrets in the underground dens.

Areas are needed where paririe dog populations can be maintained in sufficient numbers, and where ferrets will be undisturbed. A step in this direction was taken in 1953 by the release, in Wind Cave National Park (South Dakota), of three ferrets, donated by Walt Disney Productions, Inc. Another favorable site for establishing a second colony is Theodore Roosevelt National Memorial Park in western North Dakota. When suitable areas with protected prairie dog colonies are found, black-footed ferrets can be live-trapped from colonies marked for destruction, and released in these sanctuaries.

Summary.—During the period 1946–1953, a total of 50 to 70 black-footed ferrets were reported from 42 localities, mostly in South Dakota, Montana, Nebraska and Colorado. About one-third of the animals seen were found dead or were destroyed. Rodent-control operations may have added to the toll by destruction of food supply, disturbance of habitat, and direct or indirect poisoning.

Two measures are advocated: 1. A life history study of the ferret is needed to determine its ecological requirements and other needs that are basic to perpetuation.

2. Populations of ferrets should be established on sanctuaries where large colonies of prairie dogs can be maintained undisturbed. Ferrets can be obtained by live-trapping animals from areas where prairie dogs are to be exterminated. Wind Cave and Theodore Roosevelt National Parks are possible sites if the above requirement can be met.

Arrangements were completed in March, 1954, between the Fish and Wildlife Service and the National Park Service, whereby the former agency will release in the parks those ferrets that can be live-trapped from areas scheduled for rodent-control operations.

U. S. Department of the Interior, National Park Service, Washington 25, D. C. *Received February 10, 1954.*

GENERAL NOTES

POSSIBLE ANTI-ADRENALIN ACTION OF SHREW VENOM

The nature of the effect of shrew venom (*Blarina*) on mice, rabbits, and cats was reported by Pearson some time ago (Jour. Mamm., 23: 159–166, 1942). Its singular effects are now well known. My results in injecting mice were the same as Pearson's, with the exception that the venom also appeared to be a lachrymator. Pearson found that mice injected with the shrew extract exhibited uncontrolled twitching movements of the body and gave evidence of apparent irritation of the region injected. Intra-peritoneal injections resulted in a dragging of the hindquarters. These symptoms were immediately followed by a marked slowing of the respiratory rate and a generally depressed condition. The mice preferred to sit quietly with half-closed eyes, not responding readily to stimuli; the breathing was labored.

Method of preparation.—The submaxillary glands were ground with sand and 2 cc. of normal saline solution, to this was added an equal volume of chloroform. This was centrifuged for 15 minutes and the top layer was drawn off and evaporated. This dry residue was dissolved in normal saline and used in injections.

I was not able to carry this work further, but feel that some of the results may be worthy of further investigation.

1. A female cat weighing 3 kilo. was anesthetized with Nembutal. Then .6 cc. of shrew extract was injected via the femoral artery, and immediately afterwards .5 cc. of adrenalin was injected via the same route. Respiration, and blood pressure from the carotid artery showed no increase. This was repeated 5 minutes later.

2. A male cat weighing 3.5 kilo. was given Nembutal anesthesia. Then .4 cc. of shrew extract was injected via the femoral artery. After an interval of 8 minutes, .1 cc. of adrenalin was injected by the same route. Once again the kymographic record showed no response to the adrenalin.

3. A female cat, 2.4 kilo., was given Nembutal anesthesia. A series of shrew extract injections was given via the femoral artery, amounting to 1.2 cc. Five minutes after the last shrew extract injection, .1 cc. of adrenalin was injected by the same route. There was no response. After five minutes an additional .1 cc. of adrenalin was injected with no response. After another five minutes, .1 cc. of adrenalin gave a normal blood pressure response.

The results were not consistent, as the blockage of the adrenalin did not always occur. Since the shrew uses the venom to help it overcome larger animals it would be very useful if the venom were anti-adrenalin in action.—DONALD H. DEMEULES, *6031 West River Road, Minneapolis, Minnesota.* *Received August 7, 1953.*

THE PHYLOGENETIC SIGNIFICANCE OF RODENT CHEEK POUCHES

There is considerable disagreement as to the significance of the rodent cheek pouch. For example, Hill (1937) would relate the pocket mice (Heteromyidae) and gophers (Geomyidae) more closely than is generally done, with a major basis for so doing being the presence and similarity of the pouches. Most other workers accord the pocket mice and the gophers each familial rank. Some workers (e.g. Miller and Gidely, 1918) disregard the "internal" pouches of the squirrels (Sciuridae) and the "external" pouches of the gophers (Geomyidae) and relate these two families into a single superfamily (Sciuroidea).

Four genera of palaearctic true hamsters (*Cricetulus*, *Cricetus*, *Phodopus*, and *Mesocricetus*) have internal cheek pouches while the African hamster, *Mystromys* lacks the cheek pouch. Conversely, three African genera of Muridae (*Cricetomys*, *Saccostomys* and *Beamys*) have internal cheek pouches while other palaearctic genera do not. Ellerman (1941) points out that the African gerbil (*Desmodilliscus*) also possesses internal cheek pouches and therefore cheek pouches are not restricted to fossorial rodents. Of the sciurids, only the fossorial forms possess pouches while the tree forms do not, although apparently having an equal need for such pouches.

The external cheek pouch apparently occurs in only two families of rodents, Geomyidae

and Heteromyidae. As Hill (1937) points out, the musculature of the pouches in these two families is almost identical.

Huber (1930) suggests that in therian mammals the platysma and the sphincter colli profundus, derived from the primitive sphincter colli of reptiles, invade the face and differentiate into the various superficial facial muscles. The platysma gives rise to the platysma colli et faciei and the post-auricula-occipital musculature. The sphincter colli profundus gives rise to the preauriculo-temporo-frontal muscle complex, the musculature around the eye and the muscles connected with the nose, lips and cheek wall. This has been accepted by numerous workers as the basic plan for all therian mammals.

In rodents such as wood rats, which have no cheek pouches, the buccinatorius originates on the premaxilla and maxilla along the curve of the incisor and passes ventrally to insert in the orbicularis oris, decussating in the mucous membrane and fat tissue on its way to the insertion (Howell, 1926).

In described rodents that have internal cheek pouches (pouched cricetines and sciurids) the buccinatorius forms the longitudinal muscles of the pouch (Parsons, 1896; Priddy & Brodie, 1948), is derived in its entirety from the trapezius, and is comparable to the auricular portion of the trapezius of *Dicrostonyx* (Meinertz, 1941*a*, 1941*b*) and other related forms. This description of the pouch musculature seems to hold true for all rodents with internal pouches except *Peromyscus*. In *Peromyscus* (Priddy & Brodie, 1948) the insertion of the auricular part of the trapezius is in the skin near the base of the pinna of the ear. This coincides with the fact that *Peromyscus* lacks a pouch retractor. The pouch of *Peromyscus* is in a relatively primitive stage of development. The pouch itself is no more than a membrane and the musculature, if present at all, is very indistinct.

It is evident then that the internal pouch is an evagination of the oral cavity and that this evagination has carried with it the buccinatorius for its musculature. The development of the internal pouch remained internal to the platysma and the sphincter colli profundus (Bryant, 1945), which are altered in correlation with the pouch development. The pouch is also internal to the auriculo-labialis and the sphincter colli superficialis (Hill, 1937), the former inserting in the orbicularis oris.

In the case of external cheek pouches, the anterior portion of the buccinatorius inserts in the orbicularis oris and the action is to constrict the mouth posterior to the incisors. The posterior portion of the buccinatorius, however, inserts on the mandible, thus making it a masticatory muscle, with which it is sometimes grouped (Hill, 1937; Howell, 1926, 1932). The Geomyids and *Dipodomys* (Hill, 1935; Howell, 1932) have the retractor derived in part from the trapezius and in part from the platysma. The auriculolabialis and the sphincter colli superficialis insert on the lateral surface of the pouch, decussating slightly with one another (Hill, 1937).

Apparently the external pouch has evolved as an invagination of the external cheek. The fact that the internal and external pouches had entirely different developments is further substantiated by histological studies (Fulton, Jackson and Lutz, 1947) which show the internal pouch to be lined with typical stratified squamous epithelium while the external pouch is lined with the characteristic external integumental covering. Evidently either type of pouch could have developed from an animal with a plan similar to that described for the wood rat.

From the nature of the evidence cited it may be assumed that if internal cheek pouches were to develop in any rodent the musculature of these pouches would be essentially as described. If this assumption is correct then the presence or absence of the internal pouch would appear to have little or no importance in phylogenetic ranking.

As with the internal pouches, the muscular development of the external pouch probably had very little if any leeway in its development and the present situation is more than likely the only possible result.

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ROBERT B. CHIASSON, *Department of Zoology, University of Arizona, Tucson.* *Received April 12, 1953.*

MALOCCLUSION IN THE RAT

Cases of malocclusion in the incisors of rodents and lagomorphs are encountered from time to time. Hamilton (AMERICAN MAMMALS: 65, 1939) cited instances among rats, tree squirrels, muskrats and woodchucks, and illustrated one example of the last-named species. In these forms the incisors, which grow continuously from pulp cavities open at the base, are normally kept sharpened and worn down to proper size by attrition against their opposite numbers. Their potentials for growth, when unhindered, are tremendous. Shadle *et al.* (Anat. Rec., 64: 321–325, 1936) reported a total annual incisor production of 20.5 inches per animal extruded and worn away in captive rats. Should a foreign body become lodged between these teeth, or one of them become broken, the lack of normal wears allows prodigous growth, usually resulting in the animal's death.

The case reported here is that of a laboratory-raised albino rat, *Rattus norvegicus* Berkenhout, used in a study of genetic factors in dental caries. The rat was fully adult when killed, the skull measuring 44 mm. in length and 22 mm. in greatest width. The cause of the abnormal growth is not known, but may have been a fracture of one or more of the teeth during routine examinations. The enlarged incisors have all continued to grow along their normal curves. In the lower jaw the two incisors are about equally developed, 22 mm. in length from the gum line along their outer circumference, and separated by a distance of 6 mm. at their tips. In the upper jaw the left incisor, which measures 23 mm. in length along its outer edge, is some 7 mm. longer than the right and curves back to nearly reach the palate; these two teeth are adjacent. Considerable necrosis is apparent in the bones of the roof of the mouth at the anterior extremities. The palatal portions of both premaxillaries are deeply eroded, and in the right premaxillary a large pit next to the nasal bone exposes the root of the incisor. Another deep pit is conspicuous in the right maxillary beside the anterior palatine foramen.

This specimen represents one of the most advanced cases of this sort among 9,500 rats reared since 1937. H. R. Hunt, who has conducted the study, reports that similar instances occur in about one out of every two or three hundred rats. The incidence of such radical cases in the wild must be extremely small, for overdeveloped incisors of this type would soon lead to death from starvation due to the animal's inability to gnaw, ingest, or masticate food properly.—RICHARD H. MANVILLE, *Dept. of Zoology, Michigan State College, East Lansing.* *Received June 1, 1953.*

USE OF CRAYFISH FOR CLEANING SKELETAL MATERIAL

The rather sudden demise of a small dermestid colony prompted the writers to look for some other method of cleaning skeletal material, particularly small skulls, which would obviate the tedium of maceration or boiling techniques.

The chance observation of a perfectly worked out snake skeleton in a small stream by one of the senior author's students suggested that crayfish, which are natural scavengers, might be partly responsible. Consequently a number of crayfish of various sizes and species were collected and put into medium size aquaria with the object of testing the feasibility of using them for cleaning skeletal material. No previous reference to the use of crayfish for this purpose could be found in the literature.

The specimens were segregated roughly as to size and species and were then kept for several days without food. A small species obtained from ponds and from shallow, sluggishly moving water in streams was in general more tolerant of starvation and aquarium life than a larger species obtained from deeper and more rapidly moving water in streams.

After being deprived of food for several days, food was offered to the crayfish in the form of fresh skulls of various sizes. The hungry animals readily attacked the skulls and picked them clean of flesh in a surprisingly short time. In some instances small skulls from shrews, bats, and small mice were thoroughly cleaned in less than 24 hours. The only portion of the flesh not eaten was the tough connective tissue forming the roof of the hard palate. This could be easily removed with a forceps.

Certain limitations in the method soon became apparent. It was found that small skulls given to small crayfish ranging from ½–1 inch in length were worked out quite thoroughly with no damage to the skull. However, when larger crayfish were used the braincase of some of the more delicate skulls, such as those from bats and shrews, was crushed by the large chelae in order to get at the brain. Smaller crayfish removed the brain through the foramen magnum without damaging the braincase. Larger skulls, ranging from the size of a cotton rat to a small woodchuck, were worked out quite satisfactorily by crayfish from 2–4 inches in length. Although not tried, it is presumed that still larger crayfish might work more efficiently upon even larger skeletal remains. Another limitation in the method is that several skulls, if placed in an aquarium, soon undergo a certain amount of bacterial decomposition and pollute the water sufficiently to cause the death of the crayfish. This could be overcome to some extent by increasing the number of crayfish in the aquarium and by maintaining a constant inflow and outflow of water. The species taken from rapid waters was fairly susceptible to chlorine in the water whereas those specimens taken from ponds or semi-stagnant water were more tolerant of chlorine and also of anoxic conditions caused by pollution. Where a source of biological water is available chlorine would not constitute a source of mortality.

It seems probable that the above-described method might prove useful where small quantities of skeletal material are involved and where it might prove undesirable to maintain a colony of dermestid beetles. If the method is used the following recommendations are in order: 1) Adjust the size and number of crayfish used to the size and amount of skeletal material to be cleaned. There is little danger of pollution if only one or two small skulls at a time are given to small underfed crayfish. Cleaning is usually accomplished in less than 48 hours. With larger skulls and larger amounts of skeletal material steps must be taken to avoid pollution, and species which seem to be the most tolerant of pollution should be used. Crayfish should also be larger in size. 2) Keep the crayfish underfed. Well fed animals will not feed on the skeletal material, creating a pollution problem. 3) Offer only fresh material to the crayfish. Dried flesh on skulls and other skeletal material is rejected and adds to pollution in the aquarium.

We would like to offer certain other suggestions having further possibilities. As yet, these have not been tested. Should a small stream be located conveniently nearby it might be feasible to anchor a wire cage in the stream bed in which crayfish and skeletal material might be placed. This would overcome one of the main problems of pollution as well as maintaining normal temperatures and oxygen tensions of water for the crayfish. Another possibility is that the large crushing chelae might be removed from larger specimens that

are kept in laboratory aquaria. As the large chelae are mainly used for holding and crushing, some of the smaller skulls might be cleaned more rapidly and in an undamaged condition by larger crayfish inasmuch as the maxillipeds and walking legs are the chief appendages used in removing flesh from the skeleton. If the appendages are removed at the natural breaking point little mortality should occur.—JOHN A. SEALANDER AND ROBERT G. LEONARD, *Zoology Department, University of Arkansas, Fayetteville.* *Received June 7, 1953.*

HANDLING SMALL MAMMALS

The decline in availability of cloth salt and sugar sacks, so helpful in handling live-trapped small mammals, has been more than compensated for by the packagers of fresh fruits and vegetables. The plastic bags which are readily obtained through purchase of onions, carrots, apples and other items have increased advantages over cloth sacks in weight, texture and transparency. A plastic bag measuring 8 x 15 inches weighs only about 7 grams, or roughly one-third the weight of a light cloth sack. This results in less handling of balance weights; and, since plastic is less susceptible to wetting, greater accuracy in weighing is also obtained. The smooth surface prevents small mammals from climbing the sides once they have leaped to the bottom, and the difficulties resulting from entangled toe-nails are eliminated. The transparency of plastic bags is a definite aid in examining the animal dorsally, and it is much easier to jockey the mammal into position for grasping it by the scruff when its movements are readily observable. The thinness of the plastic allows the handler a greater sense of touch, and probably reduces injury to the mammal. The best position for handling the mammal is as close as possible to the mouth of the bag, with its head pointed outwards. The dimensions, 8 x 15 inches, seem ideal for mice, since the width of the mouth is ample for turning back once the animal has been grasped, and the depth is sufficient to prevent jumping-out. Light plastic is no barrier to sharp teeth, and small tears should be guarded against, since they are readily enlarged.—KILE R. BARBEHENN, *Department of Conservation, Cornell University, Ithaca, N. Y.* *Received July 18, 1953.*

NOTES ON MAMMALS FROM EASTERN NEBRASKA

Since the last published report concerning the grey eastern chipmunk *Tamias striatus griseus* (Velich, Jour. Mamm., 28: 185–186, 1947) at least three chipmunks have been taken in the Fontenelle Forest Reserve, Sarpy County, Nebraska. One of these—a mounted specimen—is on temporary loan and displayed at the House of Yesterday, Hastings, Nebraska. The last reliable sight record of this animal in the Reserve was made on April 27, 1953, by Mr. Dick Wolkow, State Conservation Officer.

An eastern flying squirrel *Glaucomys volans volans* was taken in the Fontenelle Forest Reserve in March 1950. The skull is in the writer's collection of study skin material. Some years ago a flying squirrel was taken near the South Omaha Bridge just north of the Reserve. Flying squirrels are occasionally taken at Peru, Nemah County, and Nebraska City, Otoe County, Nebraska. Last winter a tree-cutting crew told the writer that they had seen a flying squirrel at Florence, Douglas County, Nebraska, while cutting down a large elm tree.

On Christmas Eve in 1951, a perfect, completely albinic cottontail rabbit *Sylvilagus floridanus mearnsi* was brought in to be mounted. The animal was taken by Mr. Joseph Benak of South Omaha with a wire snare in the Fontenelle Forest Reserve.

A hoary bat *Lasiurus cinereus* taken in Bellevue, Sarpy County, Nebraska June 6, 1953 is the first of this species taken in the county. The animal was collected by tree trimmers and mounted for Mr. Carl Lindsay of this city. The specimen contained two well-developed embryos with an average length of 42 mm. The skull is in the writer's collection.

During the past few years there has been much talk and speculation concerning a "lion" roaming about in Eastern Nebraska. (OUTDOOR NEBRASKA, Winter issue, 1952) On Sunday, November 15, 1952, about noon, Mr. George Meyer of this city hunting rabbits near Silver City, Merrick County, Nebraska came upon a large male bobcat *Lynx rufus rufus* in a deep, thinly timbered gulley. The animal was killed with a shotgun, the pellets hitting the left temporal region of the skull. The specimen weighed 29½ pounds and the stomach

was found to contain portions of rabbit flesh and matted hair. The skin was subsequently made into a rug but the skull is preserved in the writer's collection. The story and photograph of the dead bobcat were published in the OMAHA WORLD HERALD, November 17, 1952—RALPH VELICH, *5212 South 23rd Street, Omaha, Nebraska. Received September 15, 1953.*

NEW MAMMAL RECORDS FOR ARKANSAS

On November 28, 1951, three harvest mice, two males and one female, were collected by Mr. Charles W. Nelson in the vicinity of Leachville, Mississippi County, Arkansas. The specimens were trapped along fence rows between well-cultivated cotton and soybean fields. A swampy area with a drainage ditch was located at a distance of 20 yards from the trap locations.

Subsequent examination of these mice and comparison with harvest mice from Cape Girardeau, New Madrid, Mississippi, and Stoddard counties, Missouri, and from Douglas County, Kansas has established the species as *Reithrodontomys megalotis dychei*. The Arkansas specimens agree very closely in body and skull measurements and general pelage characteristics with specimens of *R. m. dychei* from Missouri. The identification has been further confirmed by Dr. W. H. Burt at the University of Michigan. This constitutes the first known record of this species from Arkansas.

On April 24, 1952 a specimen of the hoary bat, *Lasiurus cinereus*, was collected by Mr. Lyndal York in Ft. Smith, Sebastian County, Arkansas, and sent to the writer for identification. Although this species probably has statewide distribution, it has only been reported twice previously in Arkansas; once from Little Rock, Pulaski County (Dellinger, S. C. and Black, J. D., Jour. Mamm., 21: 187–191, 1940), and once from Hot Springs, Garland County (Gregg, H. R., Jour. Mamm., 18: 98, 1937).—JOHN A. SEALANDER, JR., *Department of Zoology, University of Arkansas, Fayetteville. Received June 7, 1953.*

A NEW RECORD OF *MUSTELA ERMINEA* AND *SOREX MERRIAMI*

During the summer of 1952, a specimen each of *Mustela erminea muricus* and *Sorex merriami merriami* was trapped at Sheldon Antelope Refuge headquarters, Washoe County, Nevada by Ben Hazeltine, refuge manager. Refuge headquarters is approximately 48 miles northeast of Cedarville, California.

The weasel, a male, was caught on July 28 in a rat trap at the entrance of a burrow of a ground squirrel (*Citellus*). The stomach was found to be empty. The measurements, taken in millimeters, are: total length, 217; tail vertebrae, 48; hind foot, 28; ear from notch, 13.

On August 17, the Merriam shrew, a female, was seen to run across a lawn and down a hole. The shrew was quickly dug out and was kept alive for a day until it died. The measurements in millimeters are: total length, 90; tail vertebrae, 40; hind foot, 11.

The specimens were collected in a rolling mountainous section of the western part of the refuge. The ground, which is very rocky, grows sagebrush, *Artemisia*, and rabbitbrush, *Chrysothamnus*. On some of the hills near the headquarters there are stands of juniper, *Juniperus*, and in a few protected washes, quaking aspen, *Populus tremuloides*. The elevation at this locality is approximately 6500 feet.

About July 25, while stationed at the southern edge of the refuge, near Badger Mountain, I caught a shrew in my hand, which possibly was also a Merriam shrew. This pale individual was caught on a dry alkaline flat at an elevation of 6300 feet, covered with *Artemisia* and *Chrysothamnus*. However, this specimen succeeded in making an escape.

I wish to thank Dr. E. Raymond Hall, University of Kansas, for the identification of the specimens.—BRIAN K. MCNAB, *Museum of Natural History, Oregon State College, Corvallis. Received May 20, 1953.*

EASTERN BIG-EARED BAT IN OHIO

On April 1, 1953, a bat collected in Adams County, Ohio, was brought to me for examination. It proved to be a specimen of the eastern big-eared bat, *Corynorhinus macrotis*, apparently the first record for Ohio.

This bat was collected on March 23, by Mr. Roger McClure, Mr. William Shimp, and Mr. Philip Smith, Ohio State University students, who are making a study of the caves of Ohio for the Ohio Geological Survey. It was found in "Waggoner Ripple Cave" in Green Township, about three miles north of the Ohio River.

The cave is composed of large blocks of limestone, forming an arched passage leading down a slope at the entrance into two room-like caves, with another room beneath the second. The bat was found hanging within reach on the back wall of the second room.

The specimen was brought back and kept alive for a while, but when received at the Museum it had been dead for about two days. I was nevertheless able to make a good skin of it, which is deposited in the Ohio State Museum collection, bearing number 1716.

The specimen has been examined by Drs. Charles O. Handley Jr. and Remington Kellogg, of the United States National Museum, and they have verified my identification. —Robert M. Goslin, *Ohio State Museum, Columbus 10, Ohio. Received May 1, 1953.*

SEASONAL DISTRIBUTION OF THE HOARY BAT IN SOUTHERN CALIFORNIA

Although the subject has been studied by several workers, only an incomplete picture has been gained of the migratory behavior and seasonal distribution of the hoary bat (*Lasiurus cinereus*) in California. This results mostly from a paucity of records of this species from southern California. Through mammal collecting in Los Angeles and San Diego counties of California and study of museum collections, additional records of the hoary bat from southern California have been obtained. These records tend to fill in certain gaps in our knowledge of the migration pattern of this species. We wish to thank Seth B. Benson, Museum of Vertebrate Zoology, and Lawrence M. Huey, San Diego Museum of Natural History, for permission to examine the mammal collections in their care. The specimens that we took are in the collections of the Museum of Natural History of the University of Kansas and in the San Diego Museum of Natural History.

Hilda W. Grinnell (Univ. California Publs. Zool., 17: 332, 1918) states that this bat is found in the winter and spring in the valleys of west-central and southern California, southward through the San Diegan district. Dalquest (Murrelet, 24: 20–24, 1943), studying the seasonal distribution of hoary bats along the Pacific Coast, thought that the summer range, May to October, of females extends northward from northern California. He points out that during this period the males are scattered. According to this author, the winter range, November to April, is coastal from San Francisco, California, to the Mexican border (San Diego County). He further explains that migration begins in April and that by late May the bats have moved north into northern California. Although Dalquest's outline of the seasonal occurrence of the hoary bat is probably essentially correct, in southern California this species is present longer than he knew.

The earliest autumn records (known to us) of hoary bats in southern California are in late September and early October. A male was taken on September 30, 1951, in the San Gabriel Mountains in eastern Los Angeles County, and there are sight records at the same locality on October 10 and 19, 1951. Two females were taken on October 24, one at La Mesa and one at San Diego, both localities in San Diego County. As indicated by abundant records, hoary bats are present in coastal southern California through the winter.

In spring, hoary bats are widely distributed from the sea coast to the western border of the Mojave Desert. On April 22, 1951, a male was taken and another hoary bat was observed eight miles southeast of Llano, Los Angeles County, on the western edge of the Mojave Desert. Specimens have been taken in early April at San Diego and Point Loma, San Diego County; both localities are on the sea coast. In the San Gabriel Mountains in Los Angeles County hoary bats seemed to reach a peak of abundance in the latter part of May, where, between May 18 and 30, 1951, eight specimens were taken and many more are observed. On May 25, 1951, 22 hoary bats were captured (only two were kept for specimens) at a pond in San Antonio Canyon, San Gabriel Mountains (Vaughan, Jour. Mamm., 34: 256, 1953).

Some hoary bats remain in southern California at least into early June. A specimen was taken in Escondido, San Diego County, on June 10. In 1951, single specimens were taken in

Los Angeles County on June 8 and 10, in the San Gabriel Mountains, and on June 11 near Llano. Regarding the last three records it should be pointed out that collecting was discontinued after June 11. Hoary bats might have been taken later in June had we been able to continue collecting.

Considering the records, then, hoary bats are present in southern California until at least June 11, and they return as early as September 30, leaving only July and August as months during which this species has not been found in the area. The authors think that hoary bats probably remain during the summer in certain boreal "islands" in some of the higher mountain ranges of southern California.

The records suggest also that there is a segregation of the sexes during the spring. Of eleven specimens taken in May and early June, 1951, above 2,800 feet in the San Gabriel Mountains, all but one are males. In the lowlands of San Diego County the four records from May and early June are all of females. This rather meager evidence seems to point to an elevational separation of the sexes in late spring, the males occurring in the foothills and mountains and the females in the lowlands and coastal valleys. In California, migration of an altitudinal as well as a latitudinal nature may be the practice with hoary bats.—TERRY A. VAUGHAN AND PHILIP H. KRUTZSCH, *Museum of Natural History, University of Kansas, Lawrence.* *Received April 17, 1953.*

NOTES ON THE DEVELOPMENT OF THE LITTLE BROWN BAT *MYOTIS LUCIFUGUS LUCIFUGUS*

The following information was secured from 78 bats collected alive on July 15, 1949, from the attic of one of the occupied buildings on the Huntington Forest near Newcomb, New York. It is the purpose of this paper to show the composition of the colony, the variation in weights, and the change in the relative proportions during development.

The bats were collected by hand beneath the roof boards with the aid of a flashlight. They were chloroformed immediately and then weighed in the laboratory. Before preserving, the total length and the length of the forearm were measured to the nearest millimeter. The animals were then sexed and classified as adult or immature based upon their size, color, and length and density of hair. All adult females were examined for pregnancy. There were 65 females to 13 males, a sex ratio of 20 males per 100 females.

All of the males and nine females in the collection were immature. The sex ratio for young of the year was 13 males to 9 females, or 144 males per 100 females. None of the females were pregnant. The ratio of mature females to the young of the year was 56 to 22. This is a small number of young and may indicate a very heavy mortality of young, a very low reproductive rate for the females, or perhaps the method of collecting allowed a larger proportion of the young bats to escape.

The young bats of the year show considerable variation in size, which indicates a corresponding difference in age and therefore a long period of parturition for the species. Young bats change in relative proportions as they increase in size. The head is relatively large in young specimens and the forearm and metacarpals are relatively short at birth.

The figures in Table 1 indicate the variations in weights and measurements and the changes in relative size of the parts by expressing the lengths in terms of percentage of the part with which it is to be compared.

The structures that undergo the greatest change in growth and greatest proportional change are the metacarpals. They increase almost three times in length, growing from 20 mm. to 59 mm. and changing in proportion to the total length from 36.2 per cent to 69.6 per cent and in proportion to the length of the forearm from 100 per cent to 155 per cent.

The forearm shows the next greatest increase in size, growing from 20 mm. to 41 mm., an increase of 21 mm. or 105 per cent. In proportion to the total length it changed from 36.2 per cent to 50.0 per cent. The size of the wing is determined largely by the change in length of forearm and metacarpals, and therefore the ratio of wing surface to body size changes most rapidly of all during the growth of the bat.

The total length increases from 55 mm. to 102 mm., or an increase of 85.4 per cent. Weight

TABLE 1.—*Weights in grams, measurements in millimeters, and proportions in percentages in Myotis lucifugus*

	IMM. MALES	IMM. FEMALES	ADULT FEMALES
Total length			
Maximum	97	86	102
Minimum	55	67	88
Average	78.6	78.3	98.3
Forearm			
Maximum	41	38	41
Minimum	20	25	36
Average	34.7	34.2	38.4
Metacarpals			
Maximum	50	30	59
Minimum	20	25	53
Average	32.9	27.3	55.9
Weight			
Maximum	7.8	8.0	11.2
Minimum	3.2	4.5	6.7
Average	6.2	6.5	8.9
Forearm percentage of total length			
Maximum	46.8	50.0	44.9
Minimum	36.4	36.2	38.8
Average	43.5	43.6	40.9
Metacarpal percentage of forearm length			
Maximum	135	109	155
Minimum	100	100	140
Average	113	103	145

is the most variable measurement in the adult females, varying from 6.7 gm. to 11.2 gm., a variation of 2.3 gm. above and below the average.

The smallest bat in the collection weighed 3.2 gm. Mohr (Jour. Mamm., 11: 49–53, 1933) gives the weight of two newborn *Myotis l. lucifugus*, born in the laboratory, as 1.45 gm. and 1.55 gm., and of the largest foetus found as 1.38 gm. This indicates a birth weight of about 1.5 gm. and suggests that the smallest bat in this study group was not newborn. Therefore the changes in size and relative proportions may be even greater for the species than shown in this study.—LeRoy C. Stegeman, *State University of New York, College of Forestry, Syracuse.* *Received June 4, 1953.*

TREE ROOSTING OF THE EASTERN PIPISTRELLE

On June 19, 1952, I was walking down a foot path beside the Río San Diego, two miles west of Jiménez, Coahuila, México, when a small cluster of dried leaves hanging from the branch of a tree obstructed my way. When about to remove the leaves I noticed that a small bat hung enclosed within one of them. The animal was captured and proved to be an adult male *Pipistrellus subflavus*. It is preserved in the Museum of Natural History at the University of Kansas (KU 48273). At the same locality other individuals of this species were shot. In the flood plain of the river there were many large pecans and other trees and much rank undergrowth. The country, other than the flood plain, was arid with a shallow rocky soil and typical desert scrub vegetation. So far as I am able to determine this is the first record of *Pipistrellus subflavus* roosting in a tree; this species is usually regarded as a cave bat.—James S. Findley, *Museum of Natural History, University of Kansas, Lawrence, Kansas.* *Received September 12, 1953.*

REPRODUCTION IN TWO SPECIES OF *MYOTIS* IN JACKSON HOLE, WYOMING

The bat fauna of Jackson Hole, Teton County, Wyoming, includes at least three species of the genus *Myotis*. These are *Myotis lucifugus carissima* Thomas, *Myotis volans interior* Miller, and *Myotis evotis evotis* (H. Allen). Based upon my experience in this valley they rank in that order from the standpoint of abundance. *M. lucifugus* congregates in large breeding colonies in buildings, where, considering the adults, only females are found. Individuals of both sexes are commonly collected by shooting over standing bodies of water. I have taken individuals of the species *M. volans* by shooting over water holes in the sage flats and by hand while they were roosting at night in a cabin in a lodgepole pine forest. I have taken only three *M. evotis*. All were males and were shot over a water hole in the sage. In the spring of 1948 and 1949 I recorded reproductive data on the first two species mentioned.

The normal summer weight of non-pregnant adult female *Myotis lucifugus* is approximately 7.5 grams. During the last week in June the pregnant females gain weight rapidly and by the end of the month have gained approximately one gram. Four pregnant females taken in the last week of June, 1948, averaged 8.62 grams, and their embryos averaged 12.8 millimeters in length from crown to rump. By the end of the first week of July approximately one third of the females have parturiated and the rest are at or near term. Weight of females at term is approximately 9.4 grams. The weight of full term fetuses is 1.36 grams (average of six from July 8, 1949); their length from crown to rump is 19.0 millimeters (average of seven, same date); the forearm measures 13.3 millimeters (average of six). By the middle of July a few pregnant females may still be found but most have produced young which grow rapidly. A young animal taken on July 18, 1949, had the following measurements: total length, 53.5 mm.; tail, 16.0 mm.; hind foot, 11.0 mm.; ear, 7.5 mm.; forearm, 18.0 mm.; weight, 2.4 grams. By the end of July the earliest born young are three quarters adult size and are taking their first faltering flights. Two subadult males taken on August 16, 1949, had scrotal testes.

Pregnant females of *Myotis volans* were taken on July 11, 1948, and July 13, 1949. The average weight of five captured on the latter date was 9.8 (8.6–10.8) grams. The average and extreme measurements of their fetuses were: crown-rump length, 14.8 mm. (12.0–17.0); forearm, 7.3 mm. (5.0–10.0); weight, 0.6 grams (0.3–0.8). I judged that the larger of these fetuses would have been at term approximately one week later. A fetus, still not at term, on which the data were lost, measured 18.0 mm. from crown to rump. Three pregnant individuals captured on July 31, and August 1, 1947, one-half mile east and three miles south of Ward, Boulder County, Colorado, by E. Lendell Cockrum and John A. White, averaged 10.9 grams (10.5–11.4) and their three fetuses had an average crown-rump measurement of 29.0 mm. (24.0–34.0). Post-partum females were captured on July 26, 27, and 29, and on August 16, and 17, 1948. The average weight of three specimens taken in July was 7.7 grams (7.5–7.8) and the average weight of two August-taken specimens was 8.8 grams (8.6–8.9). The increase in weight of those taken in August presumably indicates preparation for hibernation. These data indicate to me that full term fetuses of *M. volans* may weigh more than those of *M. lucifugus* and further that parturiation in *M. volans* may take place from one to two weeks later than it does in *M. lucifugus*.

Myotis volans parturiates approximately one and one half months earlier in southern California than it does in Wyoming or Colorado. Dalquest and Ramage (Jour. Mamm., 27: 60–63, 1946) reported parturition in this species on June 4, 1945, at Old Fort Tejon, Kern County, California.—JAMES S. FINDLEY, *Museum of Natural History, University of Kansas, Lawrence. Received July 15, 1953.*

PIPISTRELLUS SUBFLAVUS OBSCURUS, MYOTIS KEENII, AND *EPTESICUS FUSCUS FUSCUS* HIBERNATING IN A STORM SEWER IN CENTRAL MINNESOTA

Central Minnesota has no known habitable caves in which bats may hibernate. A storm sewer located in St. Cloud, Stearns County, Minnesota, apparently has been selected as a substitute by three species. All three have been previously reported hibernating in the caves of southern Minnesota by G. N. Rysgaard, G. A. Swanson, C. A. Evans and others.

It is hoped that this paper will be of interest in that it indicates an unusual hibernating habitat and an extension of the range, particularly for the pipistrelles, as given by W. H. Burt and R. P. Grossenheider in "A Field Guide to the Mammals."

On December 31, 1952, long after winter had come to central Minnesota, four female and one male *Pipistrellus subflavus obscurus*, one female and one male *Myotis keenii*, and sixteen female and eighteen male *Eptesicus fuscus fuscus* were collected from this sewer. A month later, January 31, 1953, an additional male *M. keenii* and a female and male *E. f. fuscus* were found making a total winter population of forty-four bats.

The construction of the storm sewer from which the bats were collected varies from precast tile, to poured concrete, and mortar-laid granite blocks. The granite block structure, now about one hundred years old, originally served as culverts for the streets as they were built over a twenty-five foot ravine. All the bats were taken from the mortar-free joints between the granite blocks. Their heads, facing outward, were within three to six inches from the main tunnel. Only water from rains and melting snow pass through this sewer. The size varies from six feet at the entrance to three feet in diameter in other inner passages.

At the places of collection the temperature varies from 32 to 44 degrees Fahrenheit while the relative humidity varies from 57 to 92 per cent. The movement of air varies from 30 to 68 feet per minute and is dependent upon the differential between the outside and inside temperatures. Thus convection currents of air are set up so that, on cold days, air warmed as it comes inward is discharged through the manholes, and on warm days in the spring the current becomes reversed and is discharged from the entrance.

Other physical conditions of the sewer that are conducive to a hibernating habitat include frost on the walls near the entrance and pools of water in the innermost parts. No insect life has been observed except on April 15, 1952 when a few cave crickets were seen.

The five *P. S. obscurus*, hanging three in one cluster and two in another, were collected in the innermost region where the temperature and humidity were found to be the highest. Since this portion of the sewer had not been previously explored their presence here in former years is not known. On the day of collecting the temperature was 44 degrees F., the relative humidity 71 per cent, and the air current 30 feet per minute. The outside temperature was 6°F.

Of the three *M. keenii*, two were found hanging alone near the entrance where the temperature was 35 degrees, the relative humidity 69 per cent, and the movement of air 68 feet per minute. The third, a summer resident banded in this sewer on August 23, 1952, chose the environment in the rear of the sewer near the pipistrelles.

The 36 *E. f. fuscus*, with but three exceptions, occupied their crevices in solitude. While they were found to be more concentrated near the entrance where it was coolest, some were taken about one-half mile inside the sewer. Thirteen of the 36 had inhabited and were banded in this sewer during the winter of 1951–52. At this time 35 *E. f. fuscus* were collected and banded. The tolerance of this species for cold may be indicated by frozen dew within one-half inch of the bodies of two of them. Relative humidity readings as low as 64 per cent were recorded in parts of the sewer where they were collected.—HARRY H. GOEHRING, *Biology Department, State Teachers College, St. Cloud, Minnesota. Received June 13, 1953.*

SECOND RECORD OF *TADARIDA MOLOSSA* FROM SAN DIEGO, CALIFORNIA

On February 1, 1949, Mr. Bonhannon brought a live specimen of *Tadarida molossa* to the Natural History Museum. The male specimen is now No. 15974 in the collection of The San Diego Society of Natural History.

This rare bat was found hanging in an upstairs hallway in a two-story residence on Fourth Avenue, a densely settled section of the city of San Diego and marks the second occurrence for this locality and the third for the State of California.

The second-story roosting place adds further evidence to the fact that this large species requires high points from which to catch their wings for flight. The empty stomach gave no clue to its choice of food. However, the date of capture of both San Diegan specimens would suggest that this bat wanders into the northern part of its range in winter time.—LAURENCE

M. Huey, *Natural History Museum, Balboa Park, San Diego, California.* *Received July 24, 1953.*

CHOERONYCTERIS MEXICANA FROM SOUTHERN CALIFORNIA AND BAJA CALIFORNIA, MEXICO

The occurrence of the flash invasion of *Choeronycteris mexicana* at San Diego, California during September, 1946, has been recorded by Olson (Jour. Mamm. 28: 183). Being keenly interested in unusual appearances of either mammals or birds, this writer too was quick to avail himself of the opportunity to secure specimens of this bat for the collection of the San Diego Society of Natural History. I collected 39 from 11 locations, most of which were within the city limits of San Diego. Responding to newspaper publicity, telephone calls from observers reported most of the localities to me, where I found the householders not at all pleased with the presence of the bats. These calls were followed up by personal visits with the object of securing specimens. As a result of these visits a few habits of this peculiar mammal were observed.

The choice of roosts varied. They ranged from hallways of rooming houses to open patios; and from garages, where the doors were left open at night, to a cellar under a house where the ceiling was high. One specimen was captured in the Commandant's office at the Marine Depot and another in a school cafeteria. Large openings for easy access to the roosts were necessary, but high degree of darkness was not required. In fact bright shade seemed preferred, where these active bats were always vigilant and alert. When approached, they seemed to spin as on a pivot, facing the intruder with bright, black glistening eyes. From their pendant upside-down position, their long, large snouts, prominent ears and big mouths gave them a weird, ugly appearance, which was more pronounced when they ran out their long tongues, a habit that seemed to indicate nervousness. From this watchful condition these bats were quick to fly when approached and it took very agile, well directed swings to catch them with a large butterfly net, even in very bright light. The most successful way of capturing specimens was to hang a piece of fishing net in the open fly-way. They would fly against the obstruction and become tangled, after which capture was easy. Some caution at this time was necessary, for *Choeronycteris* has a large mouth, full of sharp teeth and takes every opportunity to use them.

In most places about San Diego that were observed by the writer, these bats were roosting singly and oftentimes would flush, fly out into the sunlight and return after a few moments to the same roosting spot. Only twice in San Diego were multiple numbers found and at neither locality was there any apparent segregation of sexes. In a garage at Rolando, near the eastern city limits, three were found hanging together in the darker end of an open garage. The largest number of bats, which was estimated to be from 40 to 50 individuals, was explored on October 14th. They were hanging in two groups beneath a house that was located at the head of a small gulch in Kensington Park. Part of the understructure of this house had not been closed in and was indeed an ideal site for a bat roost as the ceiling was over 12 feet above the ground. The owners told me that they had first noticed the bats about the middle of September and their numbers had varied on different days since. The bats found present on the above date were the greatest number the people had seen. Nineteen specimens were obtained and this drove them from the locality as there were none beneath the house the next day or on the several weekly calls made later.

The last bat captured from the environs of San Diego was taken from an open hallway of a four unit dwelling in North Park on December 20, 1946.

All specimens collected were dissected for indications of food. In several stomachs a yellowish paste-like substance was found, but the greater number were empty. On the faces of some of the specimens this same yellow colored matter was noted. It looked very much like pollen. In conversation with one person who had helped me capture bats in his garage on two different occasions, I was informed that he had several times seen large bats flying about banana plants that were growing in his yard. This activity was usually late in the evening, long after sunset. There were several large blossoms opening at the time and the

pollen was found to be the same color and substance as that which was smeared on several faces of the specimens. Upon dissection, no evidence of pregnancy was found.

The following year—June 1947, the writer made a short trip into the coastal district of North-Central Baja California. At a turquoise mine, located near Aguaita, about 20 miles east of El Rosario, just south of the 30° parallel, about a dozen *Choeronycteris* were seen on June 28. They were dodging in and out of the many shallow shafts and tunnels. Here also these bats seemed to choose roosting sites in bright shadow, near the openings of tunnels. In this abandoned mine they could have retreated into complete darkness had they so desired. Like those found in San Diego, the creatures were completely alert at mid-day and the four specimens taken were secured by throwing rocks into the shafts and catching the bats with a butterfly net as they rushed out.

A week earlier on June 21, five *Choeronycteris* were found hanging near the mouth of a shallow tunnel on a hillside at Rancho La Ramona, eight miles north of Santa Catarina, Baja California. They were discovered by my companion, Phillip Lichty, about 7:30 in the morning and flew out into the open rather than deeper into the darker section of the tunnel. Returning at mid-day the five were back again hanging from the ceiling in the bright shadow light. All of them flew when we appeared and during the course of an hour only three returned, which were taken as specimens. These three had their faces smeared with pollen and as large agaves were blooming profusely over the area, they were probably feeding on the pollen and nectar from their blossoms.—LAURENCE M. HUEY, *Natural History Museum, Balboa Park, San Diego, California. Received July 24, 1953.*

DECIDUOUS TEETH IN THE HOGNOSE BAT, *CHOERONYCTERIS MEXICANA*

Seven of 21 hognose bats, *Choeronycteris mexicana* Tschudi, taken by University of Kansas field parties in Coahuila possess deciduous teeth. These seven are listed below together with the number and kind of deciduous teeth present; the three specimens listed first are from 9 mi. W and 4 mi. S San Buenaventura, 2000 feet elevation; the next two specimens are from 10 mi. S Santa Teresa, 4000 feet elevation; and the two specimens listed last are from 1 mi. S and 4 mi. W Bella Union, 7000 feet elevation.

KU 48234 ♂ June 29 —di $\frac{2-2}{1-1}$, dc $\frac{1-1}{1-1}$, dp $\frac{2-2}{2-1}$.

KU 48236 ♀ June 29 —di $\frac{-}{1-0}$, dc $\frac{1-1}{1-1}$, dp $\frac{0-1}{0-0}$.

KU 48237 ♀ June 29 —di $\frac{2-1}{1-1}$, dc $\frac{1-1}{1-1}$, dp $\frac{1-0}{0-0}$.

KU 34545 ♀ August 23 —di $\frac{1-2}{0-1}$, dc $\frac{1-1}{0-0}$, dp $\frac{0-0}{0-0}$.

KU 34548 ♀ August 23 —di $\frac{1-1}{-}$, dc $\frac{1-1}{-}$, dp $\frac{0-0}{-}$.

KU 34550 ♂ September 1 —di $\frac{0-0}{0-0}$, dc $\frac{1-1}{0-0}$, dp $\frac{0-0}{0-0}$.

KU 34551 ♂ September 11—di $\frac{1-0}{0-0}$, dc $\frac{0-1}{0-0}$, dp $\frac{0-0}{0-0}$.

Most of these deciduous teeth are short, simple and hooked spicules, decidedly smaller and grossly different from their permanent counterparts. Even so, they can be identified by their position in the tooth-row of *C. mexicana* and by their permanent replacements. The inner, upper incisors are more peglike although they are slightly hooked at the ends. The lower incisors are tiny, beadlike structures; no permanent lower incisors, to our knowledge,

have been reported in this genus. Only one lower, deciduous, third premolar was found; it is noticeably different from other deciduous teeth, being premolariform although only approximately one-half as large as the permanent replacement. Allen (BATS, 1939: 169) refers to an example of this type of deciduous premolar found by Revilliod in *Archaeonycteris*.

The following notes on the dentition are based especially on the three young bats taken on June 29. In the upper jaw, the canine, second premolar and the first molar seem to be the first permanent teeth to become functional. Next to appear are the first premolar and second molar. The third molar seems to erupt before the appearance of the permanent incisors. In the lower jaw, the canine, first premolar and first molar become functional first. Seemingly, the third premolar and second molar appear before the second premolar. The minute deciduous incisors are still present at the time of the eruption of the third lower molar, and may persist for a much longer time, having no permanent teeth to push them out. In the fourteen adult *C. mexicana*, examined from Coahuila, eight have one or more of these inconspicuous teeth; one adult (KU 34549) has one of these teeth on the left side and two on the right side.

The order of elimination of the deciduous teeth is: in the upper jaw, second premolar, first premolar, incisors, canine; in the lower jaw, first premolar (if any; none was found), third premolar, second premolar, canine, incisors.

Permanent upper incisors erupt directly behind the deciduous incisors. The permanent canines appear directly in front of, and grow parallel to, the deciduous canines. In the upper jaw the permanent premolars seem to erupt immediately behind their deciduous counterparts; the latter teeth fit in the space between the permanent teeth. In the lower jaw the permanent premolars appear at the same position as, but on the lingual side of, the deciduous premolars. In these specimens from Coahuila the deciduous premolars are lost early as compared with the deciduous incisors and canines. Also, the deciduous premolars of of the lower jaw seem to drop out before those of the upper jaw, possibly because these lower teeth are forced out quicker because of the position of the replacement teeth as noted above.

The deciduous canines seem to persist longer than most other deciduous teeth. Allen (Jour. Mamm., 3: 156–157, 1922) records the presence of a persistent tooth—from his description it must be a right upper deciduous canine—in a specimen of *C. mexicana* taken on September 27 in Arizona. He regards the retention of this tooth as resulting from the uncrowded condition of the teeth in the elongated jaws of this genus.—HOWARD J. STAINS AND ROLLIN H. BAKER, *Museum of Natural History, University of Kansas, Lawrence. Received June 17, 1953.*

DEFORMED JAW IN AN ALASKAN BROWN BEAR (*URSUS*)

Recently the author had the opportunity of examining the skull of an Alaskan brown bear with a badly deformed lower jaw. The bear had been shot on the Alaska Peninsula in September of 1951 by William E. Young, Sr., of Descanso, California. The deformity was first noted by his guide, Slim Moore of Fairbanks, while skinning the bear.

Apparently a year or more previously the bear had been hit by a rifle bullet which shattered the terminal portion of the lower jaw. In healing, the free ends anastamosed and resulted in a jaw shortened by approximately one inch—the mandibles necessarily fusing at a much sharper angle than is normal. Fragments at the terminal portion, including both lower canines, became imbedded in the end of the lower lip which flapped loosely. Remnants of the rifle bullet that caused the injury were also found in the lip.

The deformity in the lower jaw caused serious malocclusion of the teeth. This resulted in considerable wear on the inner side of the upper teeth and on the outer side of the lower teeth, giving both the molars and premolars somewhat the appearance of carnasials. The upper canines had an indentation worn completely around their base. It has been suggested that this indentation may have been caused by contact with the lower canines or bone fragments still imbedded in the lower lip. As the indentation is deepest on the posterior surface of the canine, however, it seems probable that it was caused by abrasion of grass, roots or other food that the bear utilized. The malocclusion of the teeth would prevent food from

being held firmly and would tend to allow it to slip from the sides of the mouth, causing the indentation noted.

A somewhat similar abrasion of teeth by food was noted in elk by Murie (ELK OF NORTH AMERICA, 1951: 100–106). Wear on the sides of the teeth is apparently common and was attributed to abrasion occurring when the elk pulled on vegetation. This phenomenon is especially noticeable on the canines or tusks that are not apposed by teeth on the lower jaw.

Similar records of malformation of the lower jaw of bears are reported by Holzworth (WILD GRIZZLIES OF ALASKA, 1930: 290–292) who attributed the cause of fracture to the bear's habit of biting trees or posts. The muscular strength of the jaw was thought to be sufficient to cause the fracture. A common story circulated by many guides is that the fracture is caused by the accidental biting of stones when the bear is fishing. In the present instance, however, there is no doubt that the injury was due to the impact of a rifle bullet.

Although a deformity of this type would seem to be a very great handicap, the bear reportedly appeared to be in good condition and had a two inch layer of fat covering most of its body. It had been fishing in a small stream, apparently in a normal manner, when it was killed.

The fresh hide measured slightly more than nine feet square. Skull measurements are as follows: condylobasal length, 42.5 cm.; zygomatic breadth, 26.5 cm.; cranial breadth, 9.5 cm.; postorbital breadth, 16.5 cm.; interorbital breadth, 7 cm.; maxillary breadth, 9.5 cm.; palatal length, 19 cm.; and the last molar, 1.9 cm. by 2.7 cm.—CALVIN J. LENSINK, *Cooperative Wildlife Research Unit*, (The University of Alaska, the United States Fish and Wildlife Service, the Alaska Game Commission and the Wildlife Management Institute Cooperating) *University of Alaska, College, Alaska. Received May 1, 1953.*

LONGEVITY OF THE RACCOON IN THE WILD

A female raccoon, *Procyon lotor lotor* (Linnaeus), with ear tag no. 6904, was shot on the Swan Creek Wildlife Experiment Station, Allegan, Michigan, on November 11, 1952 within a half-mile of where it was originally live-trapped and tagged as a juvenile, October 6, 1940. This animal is the longest-lived of any raccoon listed in the Experiment Station files. Interval between first and last captures: 12 years and 1 month. Probable age: 12 years and 7 months.—ORLAND L. HAUGEN, *Michigan Department of Conservation, Swan Creek Wildlife Experiment Station, Allegan, Michigan. Received May 3, 1953.*

TRANS-UTERINE MIGRATION IN THE RACCOON

Trans-uterine migration is theoretically possible in most fur animals but positive proof that it occurs is known for only a few species. Enders, *et al.* (Anat. Rec. 94: 2, 1946) states that no evidence of trans-uterine migration has been observed in the fur seal. He has, however, recorded this phenomenon in the mink (Proc. Amer. Philosophical Soc., 96: 692–755, 1952). The present note establishes the occurrence of trans-uterine migration in the raccoon (*Procyon lotor*).

During routine laparotomies for embryo counts of raccoons live-trapped on the Patuxent Research Refuge, Laurel, Maryland, two cases of trans-uterine migration were found. One of these was in a female two years old, and the other in an adult known to have littered previously. Both ovariectomies were done in 1951. The operation consisted of removing one ovary, ovarian capsule, oviduct, and proximal end of the uterine horn. The cut end of the uterus was closed with a suture. Both animals were released the day following the operation. They were retrapped in 1952 and operated on again. Both were carrying three embryos, two in the normal horn and one in the ovariectomized horn. One blastocyst not only migrated but had moved up the horn and was lying close to the sutured extremity.—LEONARD M. LLEWELLYN AND ROBERT K. ENDERS, *U. S. Fish and Wildlife Service, Laurel, Maryland and Swarthmore College, Swarthmore, Pennsylvania. Received May 9, 1953.*

OVULATION IN THE RACCOON

In the course of population and management studies of the raccoon (*Procyon lotor*) on the Patuxent Research Refuge, Laurel, Maryland, the authors were led to suspect that ovulation in this species is not spontaneous, but may occur only following copulation. It is conceivable although entirely speculative that this variable in reproduction may have some significance in determining rate of recovery of animals following periods of decimation. For example, in animals in which ovulation follows copulation, the chances of reproduction at low densities might be better than in low-level populations of animals that ovulate spontaneously once each year.

In order to determine if ovulation is induced in the case of the raccoon, three sexually mature females trapped in February and early March and placed in captivity, along with a fourth that had been held in captivity for other purposes for over a year, were isolated from males before and during the normal breeding season. Two of them were known from previous records to be two years old and, in the wild, would probably have bred for the first time during this period. Another was an adult that had bred previously. Females that have been kept under similar conditions in the presence of males have bred and have borne young in captivity.

Laparotomies were performed on these animals on March 29, 1951. On this date under natural conditions it may be expected that approximately 95 per cent (80 out of 84 cases in five years of field work) of the adult female raccoons in the Patuxent Refuge area have bred and are pregnant. The single ovaries removed from the experimental animals were serially sectioned and stained with iron-hematoxylin-eosin. Although well developed follicles were present in the ovaries of the isolated adult females, no corpora lutea were found. This would suggest that ovulation in the raccoon is not spontaneous but is induced by copulation. An ovariectomy performed on a yearling or subadult female at the same time for comparison showed no indication of sexual maturity.—Leonard M. Llewellyn and Robert K. Enders, *U. S. Fish and Wildlife Service, Laurel, Maryland and Swarthmore College, Swarthmore, Pennsylvania.* *Received May 9, 1953.*

TRAPS, LIVE-TRAPPING, AND MARKING OF RACCOONS

In conducting population studies of the Ohio raccoon, *Procyon lotor*, under Ohio Federal Aid Project 14-R, "Testing Methods of Increasing Raccoon Populations," some method had to be devised to handle and examine a suitable number of animals. Being nocturnal in habit it was only rarely that one observed raccoons in the daytime as they lay sunning themselves, or as they moved from place to place. The census of den trees gave some opportunity to observe raccoons but the problem of taking these animals for examination from cavities perhaps as much as forty feet deep made the problem difficult if not impossible. A census of tree dens did not include that portion of raccoons living in other type dens, and consequently could not give a true picture of the population of any area. The live-trapping of raccoons appeared to be the only way possible whereby the total raccoon population of any area could be accurately estimated.

In 1942, traps were devised of four types embracing different principles of operation to determine those best suited to trap and hold raccoons. These were funnel traps, live bait traps, multiple hand operated traps, and a modification of the Ohio rabbit box trap. Baits of various kinds were tried, and it was discovered that, while most baits and traps produced raccoons for observation, the modified box trap baited with sardines produced the best results.

Traps.—The trap (Fig. 1) recommended as best for the live-trapping of raccoons is a humane box trap constructed of redwood, cypress, or other suitable light weight wood, and welded wire, with a drop door. The top (1″ x 11″ x 28″) and the bottom (1″ x 11″ 27″) are constructed of wood to prevent washing of the bait during rains, and the blind end is made to shelter trapped game from the weather. The wire suggested is 1″ x 1″ welded wire, No. 14 or 16 gauge. The front and side uprights (1″ x 2″ x 21″) are put together so that the door

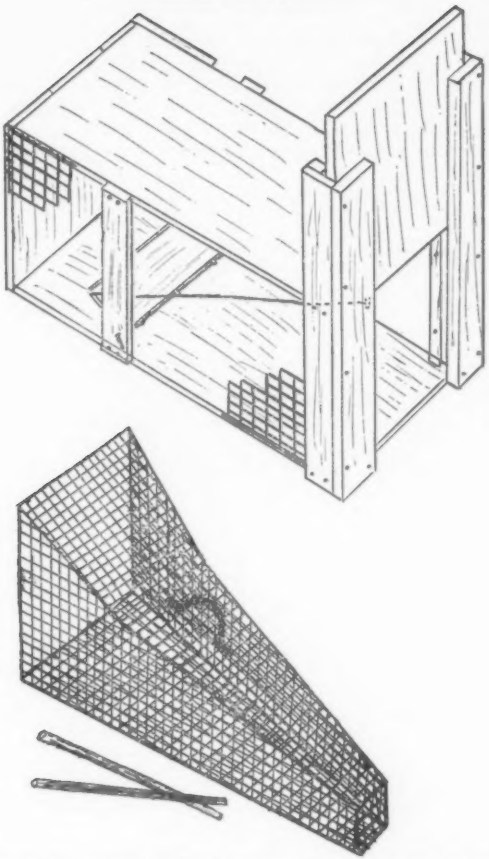

FIG. 1.—UPPER: Ohio raccoon box trap. LOWER: Handling cone and probing sticks.

fits loosely. Pieces of moulding ½″ x ¾″ are used as back stops for the door, and the door can be planed to slide more easily.

The treadle is made 1″ x 5″ x 10″ and is attached by three staples driven into one edge. As raccoons do not chew a flat surface to any extent, the treadle is invariably the part on which they turn their spite when trapped. The treadle is attached in position by running a straight section of No. 9 wire through the staples in the treadle and through the treadle uprights (1″ x 2″ x 11″).

The door is held open by using a piece of No. 9 wire from the side of the treadle to a staple on the underside of the roof and directly behind the door. The end of the wire is drawn towards the door lifting the treadle to an inclined position and allowing the drop door to rest on the wire. In this way, any weight on the treadle forces the trip wire back and the door drops. Two swing locks are attached to the uprights above the door to hold the door down when the trap is sprung.

For materials and labor for construction, traps of this type will cost $2.50 or less per trap at present prices.

Live-trapping.—During the years, 1942-1946, 415 separate raccoon were live-trapped on selected areas representing various types of habitat in Ohio. Trapping sites were selected

adjacent to all streams on the areas, and placed at intervals of one quarter to one fifth mile. In this way permanent trap sites were determined and easily located, and the trap patterns of the area devised. The painting of consecutive numbers on trees adjacent to the trap sites facilitated the location of the trap site from year to year. Normally, with this pattern of selecting trap sites, forty traps were sufficient to operate per day and trapping activities covered from 800 to 2,400 acres depending upon the spacing of the streams, and the number of raccoons trapped. Traps set at other places rather than along streams produced raccoon, but it appeared that if raccoon were moving, streams would be used extensively as travel lanes.

Trap sites selected were at riffles, sand bars, or at the junction of two streams. If trapping sites were selected along large streams, the traps were set on both sides and were wired to adjacent trees with enough wire so that the traps could float during high water. This type trap will float easily and unless it does, trapped game may be drowned.

The traps were checked each day, starting early in the morning, by two operators on foot, but in the first few days of a trapping period trap visits were seldom completed until late in the day. In one area where traps were set along a large river and where live-trapping occurred eight times in four years, it was found that the operation could be simplified by using a boat. Possibly a jeep also could have simplified transportation and operation of the program.

The bait used was California sardines packed in tomato sauce. These come in 15 ounce tins with about six fish per tin, and any one of a dozen brands was found acceptable. Traps were rebaited once a week, and the amount on fish in each tin was enough to bait five to eight traps. Bait was put both in front of and behind the treadle, and some was used as a lead bait.

Game that was live-trapped in Ohio using this bait and these trapping techniques consisted of raccoon, opossums, groundhogs, rabbits, dogs, housecats, squirrels, rats, pigs, skunks, mink and snapping turtles, in the order of occurrence. Approximately 64 per cent of all game trapped was raccoons. Opossums constituted 18.9 per cent; groundhogs, 11.4; rabbits, 1.4; and the others, less than one per cent.

Marking of raccoons.—To handle trapped game for examination, ear tagging, measurements, etc., a handling cone was constructed of 1″ x 1″ welded wire to fit into the front of the trap. The cone was satisfactory for examination of raccoons of all sizes and for groundhogs. It was not satisfactory to use for squirrel and mink, while opossums and rabbits could be examined without use of the cone. The cone fitted into the trap, and game was probed out of the trap from the open side by using a probing stick. When the game was run into the cone, two crossed sticks behind the animal prevented its movement.

The ear tagging of raccoon seems to be a satisfactory way of identifying animals, and ear tags No. 1005 obtained from the National Band and Tag Company of Newport, Kentucky, were used. Tags were inserted in each ear midway between the tip and the base on the lower rim and were applied to be free for movement. Approximately one quarter of the length of the tag extended out over the rim of the ear as any pinching of the flesh of the ear might cause the loss of the tag. In some cases it was necessary to pry the tag open for greater freedom of movement.

Of 123 separate tagged raccoon retrapped or reported killed over elapsed periods ranging up to two years, a total of 21 tags or 8.5 per cent were missing. In only one of the 123 raccoon was the identity lost due to the loss of both tags.

Measurements.—By the use of the cone the following measurements of raccoon were possible: Length of tail, length and width of feet, length and width of teeth, etc. Weight, sex, estimated age, color, external parasites, deformities, and breeding tendencies were also taken or noted.—ROBERT T. BUTTERFIELD, *Box 670, Buckhannon, West Virginia.* *Received May 23, 1953.*

A RECORD OF THE RINGTAIL (*BASSARISCUS ASTUTUS*) IN COLORADO

Rodeck (1952) establishes the range of the ringtail or bassarisk (*Bassariscus astutus*) in Colorado as the extreme western part of the state, in the sandstone canyons from Mesa

Verde in the south to the Yampa Canyon in the north. The ringtail is typically an inhabitant of arid canyon and mesa country in the pinyon-juniper vegetative type.

On April 17, 1952, Carl H. Sayles, manager of Glen-Mar Ranch on the Williams Fork River, Grand County, Colorado, shot a ringtail in the attic of the ranch house. This location is in north-central Colorado, about 25 miles south of Hot Sulphur Springs and approximately 100 miles east of the range in the western part of the state where the ringtail is more commonly found. The elevation is 8,800 feet; the vegetative type is Engelmann spruce-lodgepole pine-aspen.

The animal was an adult male; total length was 36 inches, length of tail, 19 inches. These are the only measurements that were obtained. For several days it was variously misidentified before Francis Jenkins of Granby, Colorado, finally identified it as a ringtail. The identification was confirmed by Paul F. Gilbert, Wildlife Technician, Colorado Game and Fish Department.

The skull and other skeletal parts unfortunately could not be obtained, as the carcass was burned. The pelt was tanned and is in the possession of Mr. Sayles, where it has been seen by the writer.—William H. Rutherford, *Colorado Cooperative Wildlife Research Unit, Colorado A & M College, Fort Collins, Colorado.* *Received May 18, 1953.*

BLACK-FOOTED FERRET (*MUSTELA NIGRIPES*) IN SOUTH DAKOTA

Because of the present rarity of the black-footed ferret throughout its entire range it seems desirable to put the following occurrence on record. A female of this species, weighing 699.2 grams was run over by an auto and killed on the Zeona-Strool mail route, north of Zeona, Perkins County, South Dakota, four miles north of the Moreau River, October 23, 1952. The skin of this specimen is now mounted and in the possession of Wm. T. Cox, consulting forester and biologist of St. Paul, Minnesota. The complete skeleton has been deposited in the collection of the Minnesota Museum of Natural History at the University of Minnesota.—Stanley P. Young, *U. S. Fish and Wildlife Service, Washington, D. C.* *Received April 29, 1953.*

AN OTTER CATCH ON THE GILA RIVER IN SOUTHWESTERN NEW MEXICO

On March 6, 1953, Mr. T. J. Lyon, beaver and predatory animal trapper for the New Mexico Department of Game & Fish, caught an otter (*Lutra canadensis sonora*) in one of his beaver sets. This otter was caught just north of where Lobo Canyon enters the Gila River and one mile south of the town of Cliff, New Mexico. It was a fine mature male animal, weighing twenty-five pounds: total length, forty-eight and five-eighths inches; length of tail, fifteen and three-fourths inches; hind foot, four and five-eighths inches; and length of ear, five-eighths inches. The pelage was a chestnut brown color on the upper parts and a pale buff color under the chin, sides of head and neck. Examination of the internal organs and general appearance of the carcass showed the animal to be in excellent physical condition.

Little information is available on this particular subspecies in New Mexico. The animal is extremely rare. The type specimen was collected at Montezuma Well, Arizona, December 26, 1886, by E. A. Mearns and there is one record of the Pattie brothers catching one on the Gila River near the New Mexico-Arizona line in 1825 (Bailey, N. Amer. Fauna, 53: 323, 1931).

The author has been unable to find any other records of otter catches along the Gila River drainage or tributaries within the state of New Mexico.

The Gila River where this animal was caught is normally rather small, averaging two feet in depth and 20 to 25 feet wide, except at flood times. It is bounded on either side by large cottonwood trees and willows, with an understory of grasses and weeds. Beaver are rather plentiful in some areas along the river, as well as foxes, raccoons, skunks, squirrels and birds along its banks. Fish and frogs are plentiful in the pools but not abundant in most of the stream.

If the otter migrated from Arizona, it would have to travel approximately thirty-five miles up-stream, fifteen miles of which is inhabited, with intensive cultivation along either

stream bank. If, however, the migration took place down-stream, the otter would have to travel through nine miles of cultivated area, another thirty miles of very rough, wild, and rugged country to where the middle, east, and west forks of the Gila River come together, and then another twenty to thirty miles up to the headwaters of either fork of the river. At any rate this animal had to travel several miles, part of which is over waterfalls, cataracts and a very rough terrain, to reach its capture site.—Jim McClellan, *P.O. Box 597, Silver City, New Mexico.* *Received April 16, 1953.*

WALRUS SKULL (*ODOBENUS*) FROM BLUEHILL BAY, MAINE

A walrus skull was dragged up from the bottom of Bluehill Bay, Maine, in a commercial scallop drag by Owen Billings of Stonington in December 1952.

The skull, minus the lower jaw, was taken from marine blue clay bottom between Bartlett's Island and Hardwood Island in about two hundred and thirty feet of water. It is badly eroded and partly fossilized. Its size and the fissures between the skull segments indicate the animal was a young adult. The tip of the left tusk is broken off about 53 mm. from the end.

Billings has turned the skull over to the Maine Department of Sea and Shore Fisheries for exhibit at its research station at Boothbay Harbor.—Robert L. Dow, *Department of Sea and Shore Fisheries, Augusta, Maine.* *Received June 14, 1953.*

A SPORADIC OCCURRENCE OF AN ALASKAN FUR SEAL

About October 1, 1951, an Alaskan fur seal (*Callorhinus ursinus*) was taken in an inland lake (68° 48′N, 136° 42′W) in the extreme northeastern part of Yukon Territory. The identity of this animal was verified from the skull and skin at the National Museum of Canada, Ottawa, Ontario. This is a remarkable instance of the sporadic wandering of this animal from its normal migration route along the Pacific coast.

Inquiries made in the area have revealed that this is the first known record. The Mackenzie Delta Eskimos have no word in their language for the species, and most of them had never seen a fur seal before. Only a few Eskimos from Alaska could recognize it. From reliable sources there are two other records of this species on the Arctic coast of Alaska, one at Point Barrow in 1925 or 1926, and one at Barter Island in 1942. In 1940 or 1941 a sea lion was taken at Herschel Island, Yukon Territory.

The lake in which the fur seal was shot was connected by a deep channel to Shoalwater Bay, part of Mackenzie Bay. According to the Eskimo who shot the seal, the lake had a slight saline content. The seal was small and thin, and was in an emaciated condition, probably the result of the quality and scarcity of the food supply. Its measurements are as follows: total length, 46½ inches; tail, 2 inches; ear, 1¼ inches. It weighed 54 pounds and was a male. The internal parasites, identified by Dr. L. P. E. Choquette, Institute of Parasitology, MacDonald College were as follows: *Cornynosoma semerme, Porrocaecum decipiens, Cordicephalus arctocephalinus.*

Since the breeding area of this species is on the Pribilof Islands, Bering Sea, the animal must have travelled, for unknown reasons, a distance of 1,500 to 2,000 miles from its normal range.—E. H. McEwen, *Canadian Wildlife Service, Aklavik, N.W.T.* *Received June 10, 1953.*

OBSERVATIONS ON THE GRAY WHALE

During the period February to May, 1952, when pelagic research was being carried out on the northern fur seal along the west coast of the United States from Cape Flattery, Washington, to Mexico, incidental observations were made by the author on the distribution and numbers of the gray whale, *Eschrichtius glaucus* (Cope) 1868. Knowledge concerning the migratory habits of this species is not complete, and it is hoped that the present account will add to information on this aspect of its life-history.

During the expedition, which covered over 3000 daylight miles, 31 whales were observed. Southbound, during February 9 to 23 from Neah Bay (lat. 48° 25′N) to Morro Bay (lat.

35° 20′N), no whales were sighted. On two days, February 26 and 27, a total of 17 whales were observed between Pt. San Luis (lat. 35° 10′N) and Pt. Vincente (lat. 33° 45′N), California. Of these, 11 were sighted off Pt. Arguello (lat 34° 35′N). Since conditions for observations during each period were not strictly comparable, it could not be said for certain that whales were absent from waters north of Pt. San Luis. Whales were not observed again until March 7. Upon returning northward from San Diego (lat. 32° 40′N), three individuals were sighted off Monterey (lat. 36° 35′N). Although four days were spent in this general area, one other whale was seen. More, however, were encountered later to the northward in the Farallon Islands—Pt. Reyes area (lat. 37° 40′N–lat. 38° 00′N). Here eight whales were seen between March 20 and 31. Thereafter, until completion of the expedition, observations were made from several ports as far north as Neah Bay, but only on two occasions were whales seen, the most northerly one being off Coos Bay, Oregon (lat. 43° 25′N), on April 9. The fact that no whales were seen to the northward after this date is possibly significant, suggesting that by May, gray whales have migrated into waters north of Cape Flattery (lat. 48° 25′N). Whenever whales were observed, migration was northerly in direction.

Although distances as far as 100 miles offshore were travelled, gray whales were never observed more than ten miles from the nearest point of land. While it is known that at times they frequent bays and lagoons, gray whales were never found closer than 1½ miles from shore.

Fourteen of the whales seen were solitary travellers, and seven were in the company of another. The remaining three comprised the largest group seen.—J. I. Manzer, *Pacific Biological Station, Nanaimo, British Columbia. Received June 14, 1953.*

CANNIBALISM AND OTHER OBSERVATIONS OF CAPTIVE GROUND SQUIRRELS

In early August, 1950, 12 specimens of *Citellus parryii parryii* were flown from Fairbanks, Alaska, to St. Louis, Missouri. These squirrels were used to establish a colony and later for experimental purposes. To date, September, 1953, there are only two survivors of the original stock. Some were sacrificed during the course of experimentation in hypothermia; some died during winter; one was eaten by mice while deep in hibernation; two were cannibalized.

The animals adapted well to semi-outdoor laboratory conditions in St. Louis. A shed, offering protection from snow and rain and yet allowing exposure to the seasonal temperature changes characteristic of St. Louis, was found to be an excellent animal house. In winters the temperatures usually varied from 25° to 40°F., although there were many days with lows close to 0°F.; and in summers the temperatures were chiefly from 72° to 84°F., with many periods during which the highs were close to 100°F. All temperatures were verified by the U. S. Weather Bureau Office in St. Louis, Missouri.

Our specimens have been maintained in various types of cages. The most suitable cage is a packing crate with about 12 cubic feet of space, partially filled with about eight to ten inches of ordinary garden dirt mixed with sand. The wooden enclosures were surrounded with ½-inch mesh hardware cloth. This mesh is necessary to prevent escape, since these animals often gnaw through wooden boards up to one inch in thickness. One large box had three individual compartments and initially one squirrel had been placed in each compartment. After a time, as a result of persistent gnawing and butting, the separating walls were destroyed and the three squirrels were then free to roam in all three compartments. The enclosure thus became essentially one common cage.

All the squirrels made nests varying in depth from two to six inches. Excelsior, previously placed in all the cages, was used to line the nests and as a covering material during the hibernating periods.

The squirrels hibernated during the low temperature periods of the winters 1950–51, 1951–52, and 1952–53. They "slept" in deep hibernation for various periods of time, many for four to six weeks, others for as little as two weeks and some for as long as eight weeks. The animals were often wholly buried in excelsior and dirt. They had all assumed the characteristic rolled-up posture of hibernators. This condition has been described in detail (Johnson, 1931). In the large cage, with the three animals, group huddling was the general practice.

The author observed that the three animals did not go into hibernation at the same time. Often only one specimen was fully in torpor and the other two remained active; at other times, two specimens became torpid and one remained active. A torpid squirrel did not appear disturbed by the presence or contact of its companions. Similar behavior has been reported for specimens of *Citellus lateralis* grouped in a cage (Mullally, 1953).

Interruptions of winter sleep were frequently accompanied by a rise in ambient temperature of a few days duration. The squirrels awakened for periods ranging from several hours to a few days. Emergence from hibernation of *Citellus tridecemlineatus* and *Citellus franklinii* was found to be dependent upon soil thawing resulting from a rise in temperature (Wade, 1950). Mullally (1953) reports that through the course of the hibernating season, captive *Citellus lateralis* was more active during periods of warm weather. It may well be that elevated environmental temperatures are operative in the interruption of hibernation in some species of *Citellus*.

The periods of interrupted hibernation were accompanied by feeding and considerable movement about the enlosures. Purina laboratory chow was always present in the cages. During winter or cool seasons carrots were often left in the cages, and vessels with water were always available to the squirrels. A few squirrels maintained in heated laboratories showed a lethargy during mid-winter (1950–51) never observed in spring or fall. Sometimes during summer they rolled up in the hibernating posture for considerable periods during the heat of the day. This may be a kind of lethargy, but not one that is comparable to that which occurs indoors in winter. In summer the squirrels appear to be uncomfortable due to the heat, often lying on their backs with underparts exposed. This position apparently affords some relief.

The author has worked with Arctic ground squirrels since the summer of 1948 (Wilber and Musacchia, 1950; Musacchia and Wilber, 1952). The large colony maintained at Point Barrow, Office of Naval Research, Arctic Research Laboratory, is in part due to the results of field collecting work during 1948, 1949, and 1950. During those years from 25 to 40 animals were usually on hand for study at any given time and cannibalism was never found to exist in the colony. On the other hand, Mayer (1953) reported that during the winter of 1950-51, a young male in the Point Barrow colony (*Citellus parryii barrowensis*) ate "half the mother, one other young squirrel, and the back of the head of a second young squirrel." The author and his co-workers have not found any cannibalistic tendencies among specimens of *Citellus* maintained at the Arctic Aeromedical Laboratory at Ladd Air Force Base, Fairbanks, Alaska. Cannibalism has been observed in *Citellus lyratus* by Cade (1951). He gives some details of squirrels eating other trapped specimens and comments that *Citellus lyratus* "will feed on dead, sick, or handicapped individuals of their own kind whenever the opportunity is afforded."

In view of these scarce reports of cannibalism among species of *Citellus* an additional account of this phenomenon in captive specimens is deemed worthwhile.

Arctic ground squirrels are known to be occasional meat eaters. A recent account of their carnivorous appetites is given by Cade (1951). It has been the experience of the author that *Citellus parryii barrowensis* readily eats scraps of caribou flesh, kidney and liver, canned corned beef and other meat products, both in captivity and in the field. Bacon and caribou flesh have been used as bait in live traps (summer, 1948, and summer, 1950). Eskimo companions, Mr. Clay Kaigilak and Mr. Chester Lampey both of Barrow Village, have related that squirrels readily eat meat.

On February 28, 1953, one of the three squirrels that had been living together in the large cage for over 1½ years had been eaten. Pieces of skin and most of the long bones, skull, vertebrae, and pelvic girdle were all that remained. The other two animals were in the "rolled-up" posture of hibernating sleep. It was impossible to determine the time of feeding, or feedings, and to ascertain if one or both remaining animals were responsible. The cages had been visited weekly and only a six or seven day period elapsed during which the cannibalism could have occurred.

During mid-March both squirrels were awake. One animal was extremely active and the

other was what may best be described as sickly and feeble. Despite the fact that there was a large supply of carrots, cabbage, Purina laboratory chow and water for both, the sickly animal ate very little in contrast to his companion. Both squirrels were lean after their hibernation sleep, and although no weights were recorded, it was plainly visible that the more healthy animal gained weight. They lived this way for about two weeks. One morning it was found that the sickly squirrel had been partially eaten by its companion. The viscera and the flesh were the first portions eaten. A few days later, the flesh and some skin of the head, some of the smaller bones, such as ribs, scapulae, and sternum had disappeared and it was surmised that they had been ingested. In addition, there had been considerable gnawing on the epiphyses of the long bones. The skull, long bones, vertebrae, and pelvic girdle were never ingested. Much of these findings is in accord with the account of Cade (1951). From a physiological point of view it would be of interest to learn more of the dietary habits of predominantly herbivorous forms, such as the ground squirrel. Furthermore, there may be reason to suspect that cannibalism and carnivorous appetites of these rodents are related to dietary requirements, possibly salts or vitamins.

It is suggested that future experimentation of the basic physiology of these interesting beasts be undertaken and diet selection tests be made. These animals make fine laboratory specimens, some are readily tamed, and in general they need far less attention than do rats or guinea pigs.

These studies have been made over a number of years as ramifications of problems supported by contracts numbered AF 33 (038) 422-82049, AF 33 (038)-30103, and the Arctic Institute of North America. An expression of gratitude is offered to the former Directors of the Arctic Research Laboratory, Dr. L. Irving of the U. S. Public Health Center, Anchorage, Alaska, and Professor G. MacGinitie of the Kerckhoff Marine Laboratory, Corona Del Mar, California, and to Dr. C. G. Wilber of the Army Chemical Center, Maryland, a collaborator on many Arctic research problems.

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X. J. MUSACCHIA, *Biological Laboratories, St. Louis University, St. Louis, Missouri.* *Received September 3, 1953.*

SEVEN FETUSES IN WESTERN FOX SQUIRREL (*SCIURUS NIGER RUFIVENTER*)

The following litter-size averages have been reported for fox squirrels (*Sciurus niger*): 3, Seton (LIVES OF GAME ANIMALS, 1937); 3.02, Allen (MICHIGAN FOX SQUIRREL MANAGEMENT, 1943); and 2.51, Brown and Yeager (Illinois Nat. Hist. Survey Bul. 23, Art. 5: 449-532, 1945). Baumgartner (Ohio State Univ., Unpub. Thesis, 1940) found litter-size averages to vary from 2.58 to 3.94 for various years in Ohio, while Allen reported yearly averages ranging from 2.25 to 3.25 in Michigan. Brown and Yeager (*loc. cit.*), in Illinois, listed averages that varied from 2.20 to 3.75.

Examination of 170 litters in Michigan revealed a range from one to six animals per litter; however, there was only a single record of six (Allen, *op. cit.*). Seton (*op. cit.*) lists a range of two to five and Trippensee (WILDLIFE MANAGEMENT, 1948) one to five animals per litter. Dr. Lee E. Yeager (in a personal interview) reported that five was the largest litter size observed in the Illinois study cited above.

On March 3, 1953, a gravid fox squirrel was collected by the writer at Owl Creek Reservoir, Weld County, Colorado. The squirrel habitat here is far from optimum, being composed of a narrow strip of cottonwood trees between irrigated and dry lands, where there is apparently little suitable food within the cruising radius of these animals. The specimen taken weighed 879 gr. and measured 480 mm. in total length. Examination revealed that this female contained seven fetuses, three in the right horn of the uterus and four in the left. The right horn contained one male and two females, while the left held equal numbers of each sex. Rough measurements of these fetuses ranged from 40 to 50 mm., and none was in the process of being reabsorbed. The fetuses were preserved intact and are in the collection of the Colorado Cooperative Wildlife Research Unit, Colorado A & M College, Ft. Collins, Colorado.

Six other fetal counts made by this writer in Colorado have indicated litter sizes ranging from 3 to 5, with an average of 3.83.—ROBERT L. HOOVER, *Colorado Game and Fish Department, Eaton, Colorado. Received May 5, 1953.*

HYBRIDIZATION BETWEEN *PEROMYSCUS MANICULATUS OREAS* AND *P. M. GRACILIS*

Since 1948, a number of matings of *Peromyscus maniculatus oreas* from Longmire, Washington, with *P. m. gracilis* from Pine Lake, Michigan, have been made in the Laboratory of Vertebrate Biology at the University of Michigan. The *oreas* stock was started with 25 field-caught mice, of which three pairs left offspring. Two of the three females in these fertile matings were pregnant when caught, and the present laboratory stock has therefore descended from a maximum of eight individuals. The breeding record of this stock in our laboratory is relatively poor. In contrast, the fertility of our stock of *gracilis* has always been rather good. The *gracilis* stock was built up with 31 field-caught mice, of which six pairs left progeny.

The crosses consisted of eleven individual matings of the type ♀ *oreas* × ♂ *gracilis*, ten individual matings of the reciprocal type, and one mass mating involving seven *oreas* females and four *gracilis* males. Each of the matings was continued for a period ranging from a few months to about one and one-half years. No offspring were obtained from the individual matings. In the mass mating three *oreas* females each produced a litter. One litter of two offspring was dead when discovered, another of an unknown number of young was missing when the mating was examined soon after birth had occurred, and the third consisted of a single male animal which lived to the age of seventy-eight weeks when he was harvested for cytological study and skeletal measurements. This male was retarded in growth and small in body size when compared with representative specimens of similar age and sex from each of the two parent stocks. He was mated for fifteen months to an *oreas* female, but no offspring were produced. Examination of the testes of this hybrid individual showed them to be rudimentary. On cytological study, no sperm were found in the coni vasculosi of the epididymis, and the lumina of the seminiferous tubules appeared to be surrounded by a loose protoplasmic network with scattered Sertoli nuclei. This male was patently sterile.

The failure to achieve successful hybridization between *Peromyscus maniculatus oreas* and *P. m. gracilis* tends to support Dice's (1949) suspicion that *oreas* should probably be assigned to a species other than *maniculatus*. Dice reported that in the laboratory a mixed stock of *oreas* and *P. m. austerus*, both from Oyster Bay, Washington, failed to produce any young which could be assigned to *oreas*. Twelve matings between *oreas* from Longmire, Washington, and *P. m. blandus* from Tularosa, New Mexico, failed to produce any offspring, whereas the *austerus* and *blandus* stocks were interfertile. *Gracilis* has also been shown to be

fertile with other subspecies of *maniculatus* (Dice, Jour. Mamm., 14: 298–305, 1933). Indeed, all of the available evidence on fertility relationships within the genus *Peromyscus* points to the fact that all members of a single species-group are interfertile (though not equally so) and members of different species-groups are not.

Peromyscus maniculatus oreas lives alone in the high mountains in the Puget Sound region of Washington, but in the lowlands it occurs at some places together with *P. m. austerus*, from which it does not appear to be ecologically isolated (Dice, Contrib. Lab. Vert. Biol. Univ. Michigan, 44: 1–34, 1949). The laboratory evidence given above lends weight to the notion that *oreas* is reproductively isolated from other taxonomic entities assigned to the species *maniculatus*.—T. T. Liu, *Institute of Human Biology, University of Michigan, Ann Arbor. Received June 19, 1953.*

MONOZYGOTIC TWINNING IN *PEROMYSCUS MANICULATUS*

A series of mice belonging to the subspecies *Peromyscus maniculatus bairdi*, *P. m. blandus*, and their hybrids was examined for evidence of monozygotic twinning, i.e. the production of two individuals from a single fertilized ovum. Pregnant females that were believed to be near full-term were killed and dissected, and for each specimen record was made of the spatial distribution and sex of the embryos, the presence or absence of placental fusions, and the number of corpora lutea in the ovaries.

Monozygotic twins are always of the same sex. If it is assumed that monozygotic twin embryos generally lie adjacent to one another in the uterus, whereas other embryos are distributed randomly as to sex, monozygotic twinning should result in a greater number of adjacent embryos of like sex than would be expected in the absence of other factors disturbing the embryonic sex ratio. (If embryos are considered two by two as they lie in the uterine horns, expected numbers of male pairs, female pairs, and pairs of unlike sex should be in the proportions of p^2, $(1 - p)^2$, and $2(p - p^2)$, respectively, where p is the proportion of males in the entire population of embryos.) The number of embryo pairs of like and of unlike sex was recorded for a series of 76 pairs of *bairdi* embryos, another group of 112 pairs of *blandus* embryos, and a third set of 135 pairs of embryo hybrids between these two subspecies. Expected numbers were calculated for each series, and the results were compared with the observed numbers. Chi-square tests failed to reveal any significant departures from expectation. Since this analysis did not give any indication of the presence of monozygotic twinning in these series, it can safely be assumed that such twinning, if it occurred at all, had a low order of frequency.

Six instances of placental fusion were observed in the course of this study. In three of these (one in *blandus*, two in *bairdi*) the placentas were loosely fused and were readily separated; the fetuses proved to be of different sexes in each case. In the three other instances (all *blandus*) the placentas were tightly fused and could not be separated without destroying them; in one of these, the fetuses were of unlike sex, in a second of like sex, and in the third the early death of one embryo prevented sex identification. This evidence indicates that placental fusion is not necessarily diagnostic of monozygotic twinning. At least one of these six cases of placental fusion, however, may have been associated with such twinning.

The occurrence of monozygotic twinning increases the number of embryos without any corresponding increase in the number of corpora lutea. An excess of embryos would also result from polyovulation, i.e. the liberation of more than one ovum from a single Graafian follicle, but observations of serial sections of 22 *Peromyscus* ovaries failed to reveal any evidence of this process (Liu, Contrib. Lab. Vert. Biol. Univ. Michigan, 60: 1–32, 1953). In one case of *blandus* and in two of the ♀ *blandus* × ♂ *bairdi* hybrids, the number of fetuses was greater than the number of corpora lutea, and it seems probable that these were due to monozygotic twinning. In the *blandus* case the placentas were tightly fused. Unfortunately the sex of one of these *blandus* embryos could not be determined because of its early death, but the combination of placental fusion and an excess of embryos over corpora lutea offers fairly conclusive evidence of monozygotic twinning in *Peromyscus*.

If only the cases of an excess of embryos over corpora lutea are considered as evidence of the occurrence of monozygotic twinning, a conservative estimate of the frequency of the latter can be obtained by the formula: $t = a/(n - a)$, where t is the proportion of fertilized eggs giving rise to monozygotic twins, a is the number of monozygotic twin pairs, and n is the total number of embryos. In the series of *Peromyscus* embryos described above, t has a value of .003 in *blandus*, .008 in the ♀ *blandus* × ♂ *bairdi*, and 0 in the *bairdi* and in the ♀ *bairdi* × ♂ *blandus* hybrids.—T. T. Liu, *Institute of Human Biology, University of Michigan, Ann Arbor. Received June 19, 1953.*

RANGE OF *PEROMYSCUS EREMICUS EREMICUS* IN NEVADA

Among the small mammals taken during May, 1953, by a University of California at Los Angeles field group was a male *Peromyscus eremicus eremicus*. The specimen was of about average size and coloration for the race as judged by reference to Hall (MAMMALS OF NEVADA, 1946: 509–511).

The locality of collection was eight miles southeast of Johnnie's Water, Nye Co., Nevada, altitude 4600 feet. According to Hall this extends the known range of the species in Nevada about 48 miles to the northeast from a point 3½ miles northeast of Beatty. The specimen is now No. 52443 in the collection of the Museum of Natural History, University of Kansas, Lawrence, Kansas.—Joshua A. Lee, *1325 S. Saltair, Los Angeles, 25, California. Received July 31, 1953.*

NOTES ON COLORADO PHENACOMYS AND PIKAS

During the summer of 1952, while on the staff of the Rocky Mountain Biological Laboratory at Gothic, near Crested Butte, Gunnison County, Colorado, I had the opportunity of gathering natural history observations on some of the lesser-known mammals of the region. The general region has been described by Quick (Jour. Mamm., 32: 281, 1951) and the Gothic region in some detail by Findley (Jour. Mamm., 34: 235, 1953), both in this Journal. I express appreciation to Dr. John C. Johnson, Director of the Rocky Mountain Biological Laboratory for his many kindnesses during my stay at the Laboratory. I am grateful to Dr. William H. Burt of the Museum of Zoology, University of Michigan, and to Dr. David H. Johnson of the United States National Museum for allowing me to use specimens in their care.

Phenacomys intermedius intermedius.—This vole has been taken in lodgepole pine and ponderosa pine forests elsewhere in Colorado (Williams, Jour. Mamm., 33: 399, 1952) as well as open areas. Findley (*op. cit.*) took only one specimen in the Gothic region, this one in krumholz on Gothic Mountain at approximately 10,500 ft. altitude. Lewin and Vandevere (in Calhoun, North American Census of Small Mammals, Release no. 4, 1951) did not record any phenacomys in a trapping period of apparently 180 trap-nights about 1.6 miles north of the Laboratory in 1950. In view of the suggestion made by Edwards (Jour. Mamm. 33: 497, 1952) that this mammal may be more common than is generally believed, I would like to record that five phenacomys were taken in the Gothic region in the summer of 1952. Of these, four were taken in damp situations in Englemann spruce-subalpine fir forest and one in a forb-dominated meadow, all in the Gothic Natural Area. Two were taken by Mr. Norman McCulloch, to whom I am indebted for permission to report on his specimens, and three were taken by myself. As an indication of abundance, McCulloch's two specimens were taken during a period of three nights trapping with 40 snap-traps. One of mine, taken June 21, 1952, altitude 10,400 ft., was a gravid female with seven embryos, 15 mm. crown-rump length. At the time of this animal's capture there was from one to three feet of snow remaining on the ground in the spruce-fir forest at the site. This particular animal measured 142 x 32 x 20 x 17 mm., weight 42 gr. No other specimens of this vole were taken until August 5, 7, and 8. These latter specimens were all obviously young individuals, measuring 117 x 32 x 17 x 12 mm., 15.9 gm. (♀); 121 x 29 x 18 x 13 mm., 18.1 gm. (♂); 119 x 27 x 18 x 13 mm., 19.9 gm. (♀); 122 x 29 x 18 x 15.5 mm., 20.5 gm. (♀). The 20.5-gram individual was also gravid, carrying four embryos of 10-mm. crown-rump length, all in the right uterine horn. The 18.1-gram individual was a male with descended testes which measured 5.5 x 4

mm. The seasonal fluctuation of the population of this species was especially marked, for although members of my Mammalogy class were actively trapping throughout the summer session, only one specimen was taken before August.

Ochotona princeps.—Pikas were common in the Gothic region on all suitable slides and talus slopes. A suitable slide was one where the rocks had not become stabilized to the point of catching and holding leaves, or one where the large rocks had not disintegrated to sizes small enough to obliterate interstices of sufficient size to admit pikas. Pikas must quite regularly move through terrain unsuited to them. This is demonstrated by the fact that I, as did Findley (*op. cit.*), collected a pika on a small talus outcrop, no larger than ¼ acre, well within the mature spruce-subalpine fir of the Gothic Natural Area. In addition, a "colony" of pikas was found at the head of Washington Gulch, isolated from usual pika habitat by extensive overgrazed subalpine meadows, old burns, and patches of spruce-fir, at an elevation of approximately 11,200 ft. These pikas were occupying the tailings from deserted mine shafts and prospect holes. This "colony" was further remarkable in that many individuals were apparently using burrows dug in the earth which formed the greater part of some of these mine dumps. I could not ascertain whether these burrows were dug by the pikas themselves or were possibly dug previously by the very common *Citellus lateralis*.

Other accounts to the contrary, pikas were found to be ridiculously easy to collect. A very successful procedure was to stand very quietly for about five minutes well within the boundaries of a slide, then to squeak. With some practice a fairly presentable and very successful imitation of the characteristic pika "wank" can be made by one familiar with the practice of "squeaking up" birds. After one or two squeaks a pika usually popped into view within range. A 20-ga. shotgun with an auxiliary barrel for shooting .22 cal. shot shells, loaded with dust shot, was a very successful collecting weapon.

Chances of collecting a specimen are best if you wait to shoot until the pika is facing sideways on a large, flat rock, and if it is retrieved as quickly as you can clamber over the rocks to the spot. Even though mortally wounded, a pika will convulsively kick itself far enough downward between the rocks so that efforts to retrieve by moving rocks will be futile, and dangerous as well.

By trial and error, I arrived at a fairly successful method of live-trapping pikas. A workable pika trap should have the following features. The mesh should be quite small, since pikas were observed to squeeze through 15/16-inch wire mesh. In addition, the wire should be dark-colored. The trap should have a solid top, either self-contained or possibly of a piece of roofing paper laid over the trap and held down by rocks. The bait should be visible from the entrance of the trap when it is set. Pikas were seen to try to get into the back and sides of a trap to reach the bait lying on the floor, move around the trap, and not attempt to enter the open end from which the bait was concealed by the uptilted treadle. This suggests that sight is more important to them than is scent. Dried apples were found to be a readily-taken bait, better than prunes, raisins, or fresh carrots, which were also tried. Whatever the bait is, its effectiveness is increased by "salting" the area with tiny pieces of it a few days in advance of the intended trapping. Several hours observation to learn the pikas' habitual runways will also increase trapping success.

Pikas, even more so than other small mammals, cannot well survive getting wet and chilled. Occasionally pikas were found dead in traps after a rainy, windy night that was survived by trapped *Citellus lateralis*. In the Gothic region, pikas were noted to be much more active in the morning than in the afternoon.

A captive pika accepted a number of foods, being particularly fond of the leaves, stems, and flowers of dandelion (*Taraxacum* sp.). After four months in captivity, which included an eight-day trip through 90-degree heat from Colorado to Michigan, this captive developed symptoms of a diet deficiency. Addition of slices of orange plus Jeculin (a commercial vitamin and liver compound) to the diet restored apparent normalcy. This incident brings up an interesting question as to the vitamin needs of such an alpine mammal, which is limited in its distribution to areas of comparatively thin, very clear atmosphere, and whose habitat is constantly exposed to intense solar radiation.

This captive went without water for approximately three months, or until winter put an end to an abundance of fresh, green plants and caused alfalfa hay to be substituted as a major part of its diet. In fact, when first presented with a dish of water this individual apparently had to learn how to drink. Its urine was always thick and viscous.

The larger part of the foregoing natural history observations were made on pikas inhabiting Virginia Peak between 9,900 and 11,000 feet altitude (sec. 34 and 35, T. 12 S., R. 86 W.), about one mile northeast of the Laboratory. Critical examination of a series of pikas collected from the population inhabiting this mountain reveals the fact that they are intermediate between *O. p. saxatilis* and *O. p. figginsi* in practically every character that has been used to differentiate these two subspecies. The Gothic region was early recognized by Howell (North Amer. Fauna no. 47, 1924) as an area of intergradation between these two races of pikas. Recent workers as Findley (*op. cit.*) and Hall (Univ. Kansas Publ., Mus. Nat. Hist., 5 (10), 1951) have referred specimens from this region to either one race or the other. The Gothic region falls in the zone of intergradation and specimens from there should be recognized as intergrades between *O. p. saxatilis* and *O. p. figginsi*.—William O. Pruitt, Jr., *Museum of Zoology, University of Michigan, Ann Arbor, Michigan. Received May 8, 1953. (Current address: Arctic Aeromedical Laboratory, Ladd AFB, Fairbanks, Alaska)*

FELLED TREE KILLS BEAVER (*CASTOR CANADENSIS*)

The note by Ellarson and Hickey (Jour. Mamm., 33: 482–483, 1952) describing the trapping of a beaver when the tree it was felling landed on one of its hind feet prompts me to report another accident in which a beaver became the victim of the tree it was felling. In September, 1951, Mr. George N. Lathrop of Bristol, Vermont, sent me a picture he had taken during the summer on the bank of Baldwin Creek, not far from Bristol. The animal was dead when discovered, its head pinched between the halves of the trunk, which had split above the cut a distance of some 20 inches. The tree, an ash, in falling had lodged against other trees, and it appears that while the beaver was attempting to free the base of the trunk by gnawing the small uncut portion remaining, the top shifted, causing the gaping halves of the trunk to clamp vise-like the animal's head. The beaver's weight was estimated at fifty pounds.—Harold B. Hitchcock, *Department of Biology, Middlebury College, Middlebury, Vermont. Received July 12, 1953.*

SOME MEASUREMENTS FROM A THREE AND ONE-HALF YEAR OLD BEAVER (*CASTOR CANADENSIS*)

A pregnant beaver was live-trapped near Poughkeepsie, New York, May 23, 1949. She was moved to the Wildlife Research Laboratory, Delmar, New York, and during the night of May 26 gave birth to four female kits. These young were held captive until May 14, 1952, at which time they were liberated. One of these, No. 602, was trapped and sacrificed December 3, 1952, at the age of three and one-half years. A series of measurements were recorded from this specimen. They were: Total weight, 18,500 gms. (when liberated), 15,900 gms. (when trapped); tail dimensions, 266 x 186 mm. (when liberated), 259 x 146 mm. (when trapped); carcass, 12,970 gms.; unfleshed pelt, 2,850 gms.; castor glands, 78 gms.; right oil sac, 13.5 gms.; gall bladder (full), 23.4 gms.; liver, 369 gms.; heart, 33.1 gms.; lungs, 69.7 gms.; spleen, 675 mgs.; reproductive tract (non-parous) 983 mgs.; right kidney, 44.4 gms.; left kidney, 40.5 gms.; right adrenal, 643 mgs.; left adrenal, 529 mgs.; length of small intestine, 7415 mm.; length of large intestine, 2297 mm.; length of caecum, 550 mm.; length from esophagus to caudal tip of stomach, 380 mm.; total length, 1015 mm.; length right rear foot, 155 mm.; size of the stretched pelt, 39 x 28 inches.

Skull (measurements in mm.): Total length, 129; basilar length, 114.5; palatilar length, 74.8; alveolar length of upper molar series, 32; length of nasals, 45; zygomatic breadth, 88.9; interorbital width, 29.1; mastoid breadth, 60.3; width of incisors, 7.2.—Arthur H. Cook, *New York State Conservation Department, Fernow Hall, Cornell University, Ithaca, New York. Received May 18, 1953.*

HABITAT RESTRICTION AND THE DIGGING ABILITY OF CERTAIN POCKET MICE

The restriction of certain species of small pocket mice (*Perognathus penicillatus eremicus* and *P. merriami gilvus*) to soft soils has been remarked (Denyes, Univ. Michigan, Unpub. Thesis, 1951). Borell and Bryant (Univ. California Publs. Zool., 48: 1–62, 1942) state that *P. merriami gilvus* of the Big Bend of Texas is restricted in distribution because of hard rocky soils.

In order to test the digging ability of these two species of pocket mice an experimental soil box 12″ x 12″ x 5″ deep with a hardware cloth cage over the top was constructed at the Laboratory of Vertebrate Biology, University of Michigan. First, two individuals of each species were tested separately for their ability to build burrows in sandy soil. The male of *P. merriami gilvus* had to be forced to dig by placing a strong light over the box. The female began construction immediately using the front feet for digging and the hind feet to propel the mound of sand under the body farther away. The digging was frequently interrupted to run about and scatter sand haphazardly or to obliterate the construction already begun. The completed burrows were S shaped with a center opening and only 1½″ deep. The *P. penicillatus* made much larger burrows, about 4″ deep, and with very obvious entrances in two corners.

These same mice were then tested for their ability to construct burrows in a loam soil. The burrows of both species were much more extensive, with blind ends, enlarged areas for nesting or food, and some interconnecting runways.

For the final experiment a clay loam was thoroughly wetted and slowly dried to form a cement crust about ½ inch deep over the entire surface. All the mice were highly excited by this soil surface and began digging frantically. When no progress was made by the usual methods of digging all the mice were observed to chew their way through the outer crust. Once this was accomplished and lighter soil was reached the burrows were constructed as usual except that only one entrance was made.

From this experiment it is apparent that the pocket mice, *Perognathus penicillatus eremicus* and *P. merriami gilvus*, which are generally found on sandy soils, are not unable to make burrows in harder soil. The fact that these mice are seldom taken on hard soils is probably a result of the opportunity to select more pliable soils in nearby habitats in relation to the balance between other factors which may be used as keys to selection.—H. Arliss Denyes, *Physiology Department, Florida State University, Tallahassee. Received May 20, 1953.*

PEROGNATHUS NELSONI CANESCENS IN NEW MEXICO

On January 26, 1953, Gerd H. Heinrich obtained a Nelson pocket mouse, *Perognathus nelsoni canescens* (Merriam), four miles west of White City, 3700 feet, Eddy County, New Mexico. The nearest previously reported occurrence of this species is by Borell and Bryant (Univ. California Publ. Zool., 48: (1) 25, 1942) from one mile north of Ft. Davis, Jeff Davis County, Texas. The taking of this specimen, a male (K.U. 52208) provides an extension of known geographic range of approximately 120 miles to the north for this species which seems not to have been reported previously from New Mexico.—Olin L. Webb, *Museum of Natural History, University of Kansas, Lawrence, Kansas. Received August 8, 1953.*

BUFFALO (*BISON BISON*) KILLED BY FIRE

Frank G. Roe (THE NORTH AMERICAN BUFFALO, 1951) stated on page 186, with respect to buffalo being destroyed by fire, that ". . . only two actually fatal historical cases have proved discoverable." An additional historical reference to such destruction occurs in a letter written by Ziba Smith Tuttle. It was postmarked at Fort Larima (Fort Laramie, Wyo.) June 30, 1850, and refers to an incidental observation he made on the Oregon Trail between Council Bluffs and Fort Laramie sometime during the period from May 1 to May 25, 1850.

Since the original letter, now in the possession of Mr. Reis Tuttle, Des Moines, Iowa, may not readily come to the attention of mammalogists, the significant part should be recorded: "There had been a slope of the prairie burned and it had killed hundreds of buffaloes. We saw as many as three hundred lying together with the hair all burned off them while many were roaming around deprived of their eyesight by the fire. Many were shot to put them out of their misery. . . ."

Copies of this letter were secured recently by David L. Hieb, Superintendent, Fort Laramie National Monument, in connection with historical research.—JAMES E. COLE, *National Park Service, Region Two Office, Omaha 3, Nebraska. Received August 21, 1953.*

THE FIRST PREMOLAR AND THE CANINE TOOTH IN BISON

The purpose of this note is to place on record some observations of anomalies in the dentition of bison from Wood Buffalo Park, Northern Alberta, which are of interest in their own right, and which lead to a better understanding of the correct nomenclature of the teeth normally occurring in this genus and in other ruminants. Originally Wood Buffalo Park

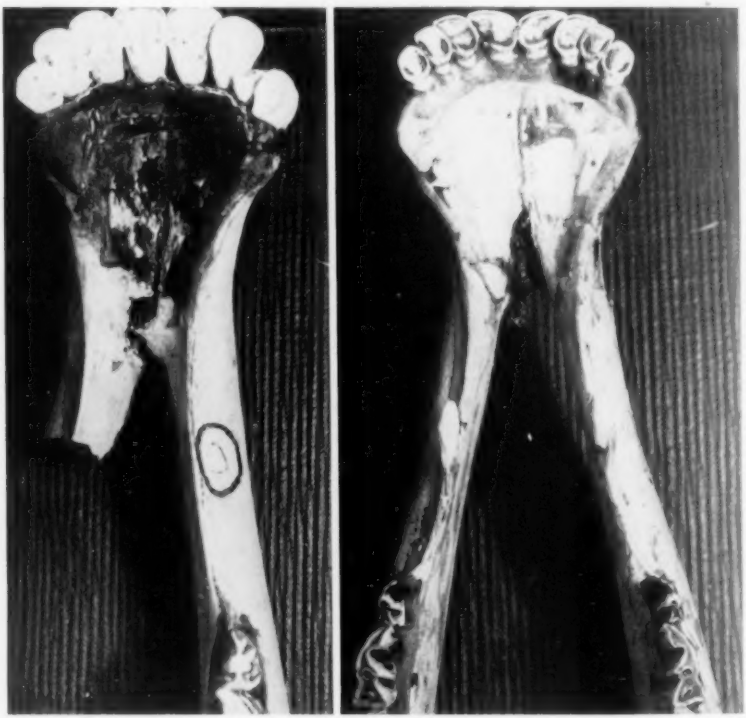

PLATE I

LEFT: The right dentary bone of a four-year old male bison showing the occlusal surface of an extra tooth thought to be the permanent first premolar. RIGHT: The mandible of a yearling male bison showing the anomalous development of paired enamel cones, thought to be deciduous first premolars

was inhabited by a small number of *Bison b. athabascae*. Between 1925 and 1928 about 6,600 *B. b. bison* were introduced. The two races interbred and the present population seems to consist mainly of hybrids bearing a closer resemblance to the plains, rather than the woods, type.

A collection of dentary bones, or entire mandibles, from bison in Wood Buffalo Park was made for the purpose of studying the dentition, and more particularly, for working out a system of age determination. Twenty-six specimens, representing a series of advancing age, were cleaned and preserved for detailed study, and approximately 600 others have been examined briefly, in the field, without removing the soft tissues. In two of the cleaned specimens, a tooth was found in the diastema, which was considered to represent a vestigial first premolar.

A portion of the right dentary bone of a male, considered to be in its fourth year, is shown in Plate I. The occlusal surface of a supernumerary tooth shows plainly within the circled area. The left member is not visible superficially and no trace of it can be found by sawing into the bone. It is concluded, therefore, that the condition is unilateral. The premolars and the incisiform teeth are permanent in this specimen, and it is therefore assumed that the supposed first premolar is also a component of the permanent dentition.

Plate I, right, shows part of the mandible of a male bison about 15 months old. A simple enamel cone, directed anteriorly, is visible in the diastema on each dentary bone. The incisiform teeth and premolars are deciduous in this specimen, and their replacement by the permanent dentition would not normally have begun for about six months. It is assumed, therefore, that this is an example of the bilateral development of the deciduous first premolar.

Approximately 200 specimens that were in the process of replacing the deciduous incisiform teeth with the corresponding permanent teeth have been examined in the field, and a difference has been noticed between the replacement of the three central pairs and the outermost pair.

The first three pairs seem to be forced out from below by the growing permanent teeth, so that by the time the deciduous teeth drop out, the permanent teeth are already at, or even above, the gum line. In other words, there is no time lapse between the loss of the deciduous teeth and the appearance of the permanent ones.

The outermost incisiform tooth is shed and replaced during the fourth year of life, typically at about three years and six months. At two major kills in 1952, 60 animals in their fourth year were examined, and the results are shown in Table 1. It will be noted that 11 of the 60 were lacking one of the outermost teeth (canines) or both. In every instance it was apparent that the deciduous tooth had been gone for some time because a tough pad was present on the gum in place of the empty socket. In contrast, therefore, with the speedy replacement of the first three incisiform teeth, there appears to be a distinct time lapse between the loss of the fourth incisiform tooth and the appearance of the permanent member.

TABLE 1.—*Stages in the shedding and replacement of the canine teeth in bison as observed at two major kills in 1952*

CONDITION OF CANINE TEETH	NUMBER OF SPECIMENS		TOTAL	
	Jan.-Feb., 1952	Nov.-Dec., 1952		
Both deciduous	11	9	20	
One deciduous, one shed	1	1	2	
Both shed	6	0	6	11
One shed, one permanent	2	1	3	
Both permanent	25	4	29	
Totals	45	15	60	

Riney (Jour. Wildlife Mgt., 15: 99–101, 1951) has drawn attention to the confusion in terminology applied to the dentition of the ruminants. He has shown that in the older fields of comparative anatomy and palaeontology, the outermost incisiform tooth is considered to be the canine, and the anterior three molariform teeth normally occurring in the living Cervidae and Bovidae, are considered to be the second to the fourth premolars. Riney also states that many investigators, in the newer field of wildlife management especially, have referred to the lower canine tooth as a fourth incisor, and to the anterior three molariform teeth as the first to the third premolars. The former system is based on evolutionary theory and fossil evidence, while the latter system seems largely a matter of convenience.

The extra teeth reported here are obviously the first premolars, which are not normally developed in the living Bovidae. Their occasional appearance is easily explained by the theory that the first premolar has been all but lost in the course of phylogenetic development.

It is also interesting to note that the canine tooth, although morphologically similar to the incisors, seems to retain a trace of its separate origin by the marked difference in its method of replacement.—W. A. Fuller, *Canadian Wildlife Service, Fort Smith, Northwest Territories. (Published by permission of the Minister of Resources and Development) Received July 25, 1953.*

MUSKOX (*OVIBOS MOSCHATUS*) LONGEVITY

During late May, 1953, a dead muskox was found floating in Etolin Strait near Cape Manning, Nunivak Island, Alaska. This animal was a cow bearing an ear tag marked U. S. Bur. Biol. Surv. Exp. Sta., College, Alaska M 33. Mr. Jack Warwick of Fairbanks, Alaska, a former employee of the Biological Survey, provided notes indicating that this animal was tagged on March 23, 1931, at College, Alaska, and that it had been born in the spring of 1930 in Greenland. Presuming that the cow died during the winter of 1952–1953, her age was approaching 23 years.

The skull of this cow is deposited at the University of Alaska. Only three incisiform teeth remain, but most of the molariform teeth retain good grinding surfaces well above the gum line. The third premolar and first molar on the left side of the upper jaw were ulcerated and were lost in cleaning the skull.—John L. Buckley, *Alaska Cooperative Wildlife Research Unit, College, Alaska;* David L. Spencer, *U. S. Fish and Wildlife Service, Kenai, Alaska* and Paul Adams, *U. S. Fish and Wildlife Service, Fortuna Ledge, Alaska. Received September 14, 1953.*

CANINE TEETH IN A WISCONSIN WHITE-TAILED DEER FAWN

A skull of a white-tailed deer fawn containing two canine teeth in the upper jaw was found March 7, 1953, in the University of Wisconsin arboretum. The skull had probably been discarded by a hunter after the 1951 "any-deer" season. The true locality of the specimen is unknown although there is little doubt that it is a Wisconsin deer (*Odocoileus virginianus*). To my knowledge there has been no record of canine teeth in a fawn white-tailed deer, or in any deer from Wisconsin.

Van Gelder and Hoffmeister (Jour. of Wildlife Mgt., 17: 100) recently called attention to the presence of canine teeth in mature white-tailed deer. They obtained records, by personal examination and from the literature, of canine teeth in 15 out of 1,275 white-tailed deer skulls. Nine out of 11 specimens from known localities were from south of the 24th parallel. The New York State Conservation Department has tooth data on 18,000 white-tailed deer and canine teeth have been found in 23 specimens (Editor's note to Van Gelder and Hoffmeister, *Ibid.*). Severinghaus found records of canine teeth in 7 out of 1,729 New York white-tailed deer taken to taxidermists (personal communication). All of the above records are of mature deer.

The Michigan Department of Conservation examines for age several thousand white-tailed deer annually, and I. H. Bartlett and L. W. Fay have kindly replied to inquiry that

they know of no records of Michigan white-tailed deer with canine teeth. The Wisconsin Conservation Department has aged over 10,000 white-tailed deer in the last four years and no canine teeth have been recorded (J. B. Hale, B. L. Dahlberg, and R. C. Guettinger, personal communications). It is probable, however, that canines are often overlooked in fresh specimens since they may be entirely concealed by the gums. The condition is very likely not as rare as the available literature would indicate, particularly in fawns, which are usually closed to hunters.

The following is a brief description of the right upper canine of the specimen which prompted this note (the left upper canine was missing although the bony socket indicated its presence): alveolus to tip on lingual side = 5.5 mm.; alveolus to tip on labial side = 7.5 mm.; width of canine at alveolus = 2.0 mm.; greatest width of canine = 3.0 mm. The skull was obviously that of a fawn under 7 months of age since only 1 molar had erupted.

Van Gelder and Hoffmeister (*Ibid.* and personal communication) feel that canines in white-tailed deer are more prevalent in Central America, although they do not know the significance of this. They speculate that the canines may have some adaptive value in the tropics (the genus *Mazama* of Central and South America has canine teeth), or that they may be a primitive character of some evolutionary significance. The prevalence of canine teeth in deer of various regions merits further study.—CHARLES H. SOUTHWICK, *University of Wisconsin, Madison.* *Received June 24, 1953.*

ADDITIONAL MULE DEER RECORDS FOR MINNESOTA

In 1947 the known range of the mule deer (*Odocoileus hemionus*) in Minnesota was extended 100 miles to the east, when H. L. Gunderson reported a deer of this species killed near Pillager, Cass County (Jour. Mamm., 29: 184, 1948).

The range of the mule deer is still expanding in Minnesota. On October 19, 1952, a car driven by Mrs. Frances M. Hammergren killed a 2½-year-old male mule deer on U. S. Highway No. 10 near Valentine Lake, Ramsey County, almost within the St. Paul City Limits. St. Paul is approximately 100 miles southeast of Pillager. The animal was skinned out by Warden Supervisor E. R. Nordin who noticed the black tail and called our attention to it. The hide and the skull minus the lower jaw were turned over to H. L. Gunderson of the Minnesota Museum of Natural History, University of Minnesota, who identified the material. The specimen is numbered 3351 in the Minnesota Museum of Natural History collection.

On March 4, 1953, Gerald T. Bue and Donald H. Ledin, biologists of the Minnesota Division of Game and Fish, saw a mule deer in a cornfield three miles southwest of Slayton, Murray County, Minnesota about thirty miles from the South Dakota Line. At the time they were flying an aerial pheasant census. As the deer jumped up, they noted its grayish coloration. Its gait was very distinctive. It held its head high and back over the shoulders as it bounced along on stiff legs down a slight incline. When traveling on level ground it used a running or single-footed gait much different from a white-tailed deer. Also its tail was not "flagged" as it bounded in fright before the plane. The deer was a large animal, probably an adult, but the sex could not be determined as it was without antlers. Four kodachrome photographs were taken of the deer. The gray pelage and black tail are readily distinguished in one of the photos.

Recent North Dakota records of the mule deer may shed some light on the distribution of this species in Minnesota. Previous to 1900 the mule deer occurred occasionally in extreme northwestern Minnesota according to Swanson, Surber, and Roberts (Minn. Dept. Conserv., Tech. Bul. 2: 15, 1945). Then in 1941 a specimen was obtained in Becker County Minnesota and in 1947 at Pillager in Cass County. These records seemed to indicate an expansion of the range southeastward with a possible nucleus of animals in the northwest corner of the state.

The recent North Dakota records which suggest an additional mule deer range expansion route directly eastward from North and South Dakota into Minnesota, are contained in a letter from Edmund Hibbard dated April 29, 1953. Mr. Hibbard, who is a biologist with the

North Dakota Game and Fish Department, stated that a 2½ year old mule deer buck was killed on November 21, 1952, in northeast Richland County along the Sheyenne River just east of Sheyenne River Park. This is only twenty-three miles west of Wolverton, Wilkin County, Minnesota. Mr. Hibbard also stated that three mule deer were seen in the hills west of Ellendale, North Dakota, by William McKean, big game biologist, on a winter aerial deer census in 1953. Ellendale is just north of the South Dakota Line and approximately one hundred miles west of Minnesota.—ARNOLD B. ERICKSON AND GERALD T. BUE, *Minnesota Division of Game and Fish, Pittman-Robertson Research 11-R, St. Paul 1, Minnesota.* *Received July 28, 1953.*

NOTOEDRIC MANGE IN THE BOBCAT, *LYNX RUFUS*

Notoedric mange caused by the sarcoptid mite, *Notoedres cati* (Hering, 1838), is a mange usually restricted to the head and neck, forming crusts until the skin becomes hard, thickened, and creased like leather. In recent years we have noted it as a fairly common and often fatal disease of Connecticut foxes and house cats. Records are meager, however, of notoedric mange in the bobcat, *Lynx rufus*. This note records a case in a bobcat which has come to our attention.

Pollack (Jour. Mamm. 32: 356–358, 1951) reported the killing of a thin six pound female in Massachusetts on May 30, 1949, which had notoedric mange, and was informed of another that was similarly afflicted but not examined by him. It was his opinion that the bobcat was seriously affected by this mange. Our case closely parallels the one he reported with respect to the ease with which the animal was approached and dispatched. A Connecticut State Trooper sighted the animal crossing a road near Washington, Connecticut, in Litchfield County, pursued, shot, and turned it over to Conservation Officer Seth J. Monroe. It was brought to the University of Connecticut on March 2, 1952, by Mr. Arroll Lamson, Game Management Supervisor of the State Board of Fisheries and Game, for our reference collection.

The animal was a female which weighed 12 pounds, 10 ounces, and was 30 inches long. A thick encrustation covering the base of the ears, parietal scalp, and dorsal surface of the neck, extending posteriorly to a point between the scapulae, was noted prior to pelting. The left side of the muzzle from the nostril to the posterior margins of the mouth and eye was also involved.

The pelt was removed, immersed in a battery jar containing 75 cc. of clear 25 per cent aerosol O T to three gallons of water and agitated periodically for 20 hours. This washing method is a modification of the one used by Lipovsky (Jour. Kansas Ent. Soc. 24: 171–156, 1951) for ectoparasite recovery with particular reference to chiggers. We recovered a large number of the mites which were identified as *Notoedres cati*. Most of them were still alive and suspended in a matrix of exuviae, serous exudate and other debris. In effect, this comprised the major bulk of the encrustation. Most of the mites were larvae, outnumbering the adults found, seven to one. Virgin females were less frequent than males and ovigerous specimens were rare, probably because the method used did not wash free the sarcoptids in the deeper brood chambers in and beneath the stratum corneum which seemed to be preferred by the ovigerous specimens.

It was not surprising that the hide, when returned from the tannery, exhibited total epilation at the central, most seriously involved areas, although the milder, peripheral encrustations remained more or less intact. It is believed that this was a relatively recent infestation and we share the opinion that notoedric mange in bobcats could possibly result in a high mortality.—LAWRENCE R. PENNER AND WESLEY N. PARKE, *Department of Zoology and Entomology, University of Connecticut, Storrs.* *Received May 28, 1953.*

DIROFILARIA SCAPICEPS FROM SNOWSHOE HARE IN CONNECTICUT

The report by Penner, Dery, and Knuckles (in press) of *Dirofilaria scapiceps* in cottontail rabbits from Connecticut and Massachusetts, aroused my interest in the possibility

that the snowshore hare, *Lepus americanus phaeonotus*, might also be found in New England infected with this filarial worm. Visits were made to the homes of several sportsmen, who were known to hunt snowshoe hare locally, in the belief that they might, for one reason or another, have saved the hind feet. Six hind feet from at least five snowshoes were obtained in this way, four of which were left, and two right, hind feet. Examination was performed by slitting lengthwise the dried skin above the tarsus of each foot with a knife. A very dry single, coiled up nematode was found under the skin of the largest of the feet examined. This was a right hind foot and had come from a snowshoe that weighed nearly six and one-half pounds. The left foot had been given to someone who wanted it as a good luck charm and the hunter who shot the hare four months previous to my visit had kept the right one because it was so big. It was also learned that the hare had been shot when the hunter had gone fox hunting during mid-January of 1953, near Abington, Connecticut.

The worm collected was placed in tap water after which it increased its size tenfold and could then be identified as a female *Dirofilaria scapiceps*, 25 mm. in length.

It would appear likely that this filarial worm is of common occurrence in the snowshoe hare in Connecticut and other parts of New England and examinations designed specifically for its recovery should bear out this contention.—Lawrence R. Penner, *Department of Zoology and Entomology, University of Connecticut, Storrs.* *Received May 28, 1953.*

A NOTE ON *MACRACANTHORHYNCHUS INGENS* IN A CONNECTICUT RACCOON

A single specimen of *Macracanthorhynchus ingens* (v. Linst. 1879) Meyer, 1933, was taken from the intestine of one of 12 raccoons examined in our laboratories during the first four months of 1953. The particular raccoon infected was an ill one picked up by a professional raccoon trapper near Washington Depot, Connecticut, on March 19. It died March 26 of other causes and later was brought to the University of Connecticut. Chandler (Jour. Parasitol., 28: 255–268, 1942) reported this acanthocephalan present in 11 of 13 raccoons from East Texas, in numbers from 1 to about 80 per host. Moore (Jour. Parasitol., 32: 387–399, 1946) gave an account of its life cycle which involves white grubs as intermediate hosts.

It is suggested that this worm, previously unreported from Connecticut, may have entered the State as a result of the cooperative importation program between the State Board of Fisheries and Game and some of the raccoon clubs in the State. According to figures provided by Mr. L. A. Williamson of the State Board, 590 known liberations from 7 states have been reported between 1946–1952, although so far as is now known, none of these states was south of Pennsylvania. It is interesting to note, in this regard, that Chandler and Melvin (Jour. Parasitol., 37: 106–109, 1951) in reporting new or rare host records of helminths from Pennsylvania mammals collected by the Pennsylvania Mammal Survey, recorded it from one *Mustela vison*, two *Mephitis nigra*, one *Urocyon cinereoargenteus*, one *Parascalops breweri*, and commonly from *Procyon lotor*.

The worm from the Connecticut raccoon is a male specimen, 70 mm. long, and the number, size, and arrangement of the proboscis hooks allows an identification of the worm as *Macracanthorhynchus ingens*. It is not unlikely that the worm can become established here and be of much more common occurrence due to the heavy raccoon and white grub populations present in the State.—Lawrence R. Penner, *Department of Zoology and Entomology, University of Connecticut, Storrs.* *Received May 28, 1953.*

REVIEWS

Ellerman, J. R., T. C. S. Morrison-Scott, and R. W. Hayman. SOUTHERN AFRICAN MAMMALS 1758 TO 1951: A RECLASSIFICATION. London. British Museum (Natural History), 363 pp., 3 maps. December 23, 1953. Price, two pounds.

Most early South African mammal collections were deposited in the British Museum and were reported by Oldfield Thomas and others. After World War I, however, the initiative in South African mammalogy shifted into local hands, and exploration of the vast mammal fauna of this unique region proceeded with remarkable vigor. These local efforts culminated with the publication in 1934 of Guy Shortridge's MAMMALS OF SOUTH WEST AFRICA, and in 1951 with Austin Roberts' MAMMALS OF SOUTH AFRICA. Both were monumental works which found wide practical application in South Africa, and which will always have a place on mammalogical bookshelves the world over. Because of their regional perspective, however, the taxonomy of Roberts and Shortridge suffered. Roberts in particular did not look much beyond the bounds of southern Africa for the relatives of the fauna he described, and he was, in some instances, too liberal with his "splitting" at all taxonomic levels. Furthermore, he was severely handicapped by lack of direct comparisons between his materials and those described by British Museum authors.

Upon this background we now have the publication of a British Museum SOUTHERN AFRICAN MAMMALS. In effect it is a retort to Roberts' publication. It extends the bounds of southern Africa to include Angola, Northern Rhodesia, Nyasaland, and Portuguese East Africa, and thus encompasses a somewhat larger fauna, but essentially it covers the same ground that Roberts did.

SOUTHERN AFRICAN MAMMALS follows the convenient pattern set by the CHECKLIST OF PALAEARCTIC AND INDIAN MAMMALS of Ellerman and Morrison-Scott. It provides statements of geographic distribution, synonymies, citations to important references, taxonomic notes, and a full complement of well constructed and usable keys. Notations indicating forms examined, and mention of the condition and whereabouts of type specimens would have been welcome additions.

In general, the classification of Simpson (Bull. American Mus. Nat. Hist., vol. 85, 1945) has been followed, but there are numerous departures from it at all taxonomic levels. Roberts' classification has been completely disavowed. His regional perspective has been replaced with a cosmopolitan perspective, and his "splitting" taxonomy has been replaced with a "lumping" taxonomy. The contrast is great. There are numerous reductions of genera to subgenera or even synonyms and a drastic reduction in the number of species (to 350) believed to occur in this area. The reasons for these actions are usually stated, so that the user of the book may make his own evaluation of the authors' conclusions. A few subspecies have been placed in synonomy, most of them without comment. All of Roberts' types have been examined by one of the authors (Ellerman), but there still has been no direct comparison between his material and that in the British Museum.

The taxonomy of these authors is not so conservative as that of most Americans, and many of their conclusions do not appear to be justified by existing study material. They actually anticipate work still to be done. Their "species" is frequently equal to the "species group" of American taxonomists. It often appears that to them the criterion for conspecificity is gross resemblance, demonstration of intergradation is unnecessary, and broad overlap of ranges of "subspecies" is an unimportant detail.

No mammalogist will deny that since 1758 too many species (and genera) of mammals have been named. Inevitably, it is not as easy now, as it was 50 or 100 years ago, to name a valid new species, and as more abundant study material has become available taxonomists have naturally turned their primary effort to revision and improvement of the nomenclature that was set up by their predecessors. Such efforts should always be applauded, for the result is a simpler and more natural classification. However, some portions of the world, whether we like to admit it or not, are still in the "exploration and cataloging" stage as far as mammalogy is concerned. There are parts of all continents of which this is true.

Some authors, including Americans, feel the urge to short-cut the "accumulation of abundant study material" stage and erect a sifted, sorted, and simplified nomenclature for the backward areas. The inevitable result is too few species in place of too many. It is illogical to call this an improvement.

There are composite species in SOUTHERN AFRICAN MAMMALS which have been formed by synonymy of two or more species without the benefit of appropriate evidence to support the action. An idea of the concepts of taxonomy that led to this situation may be had by reviewing the introductory remarks on methods (p. 2) and the remarks on the family Soricidae, from which the following passage is quoted (p. 19): "Pending a general review of the genus *Crocidura* south of the Sahara (G. Allen lists over one hundred supposed species), little can be offered by way of revision of the species now under discussion, but it does seem fairly clear that, until someone can undertake the herculean task, seven can be maintained as valid." The more than one hundred species of Allen are sifted to seven on the basis of (1) condylobasal length; (2) color of fur; and (3) ratio of tail length to length of head and body.

The treatment of the *Tatera* gerbils may be taken as another example. The authors of SOUTHERN AFRICAN MAMMALS ignore the conclusions of Davis (Proc. Zool. Soc. London, 118: 1002, 1949), which were based on field observations and on the collections of the British Museum, and recognize but one "species" south of the Cunene, Okavango, and Limpopo Rivers. Actually, as pointed out by Davis (*loc. cit.*) and earlier by Roberts (Ann. Transvaal Mus., 13: 102, 1929), there are at least two well-marked species in this area. *Tatera brantsii* (possibly = *T. afra*) and *Tatera schinzi* (possibly = *T. robusta*) occur together over a large portion of southern Africa. At many localities both species may be caught in the same trap line, but they are ecologically isolated. *T. brantsii* is partial to prairie; *T. schinzi* to savannah and woodland (Davis, *loc. cit.*); where both occur in fairly open situations, *T. brantsii* is on the looser sands.

The "broad view" approach has led to an interrupted geographic range for some "species". Examples are *Suncus etruscus*, *Crocidura suaveolens*, *Crocidura russula*, *Crocidura smithii*, *Madoqua kirkii*, and *Gerbillus gerbillus*. Although southern African populations are isolated from those of northeastern Africa, they are assumed by these authors not to be differentiated from them. For *Suncus etruscus* they state (p. 21): "Several shrews in the Union appear broadly speaking to agree with *S. etruscus*, as defined by us, in size. . . . As *etruscus* is known from Algeria and northern Nigeria, and it appears there are very small forms in Eastern Africa, we see no reason why these southern forms should not be regarded as outlying races of *S. etruscus*." Sometimes parallelism or convergence can account for morphological similarities in unrelated forms or in geographically isolated related forms.

The treatment of the African genera *Thryonomys*, *Petromus*, and *Mystromys* (p. 225) is of particular interest to American mammalogists: "Some American authors, and others, dislike referring the Thryonomyinae and Petromurinae to an otherwise South American family Octodontidae (or Echimyidae), on account of the fact that they feel African and South American genera cannot be closely allied. *Thryonomys* is a distinct genus and perhaps merits family rank, but the same cannot be said of *Petromus*, which is essentially morphologically an Octodont, and these authors usually ignore the fact that if *Petromus* is separable on a subfamily level from South American Octodontidae, it is hard to separate the South African Cricetine genus *Mystromys* even on a generic level from some South American forms which it resembles closely [*Phyllotis* and its allies]."

While there is room for disagreement with many points in this classification of Ellerman, Morrison-Scott, and Hayman, there are at the same time other points which seem quite reasonable. For example, their treatment of the Pinnipedia as an order; *Proteles* as belonging to a distinct family, Protelidae; *Thos* as being a synonym on *Canis*; and the inclusion of the kudus in the genus *Tragelaphus*. Time, additional specimens, and more comparisons, will test their classification.—CHARLES O. HANDLEY, JR., *U. S. National Museum, Washington, D. C.*

Odum, Eugene P. FUNDAMENTALS OF ECOLOGY. Philadelphia—London. W. B. Saunders Company, xii + 384 pp.; illus. 1953. Price, $6.50.

Most of the books on Ecology that have been published in recent years apparently have been directed at the specialist in this field of science. The book under consideration is directed at the beginning student in Ecology and the worker in other related fields who desires a quick reference to the general principles of ecology, without all of the technical details and minutiae that go with them. The treatment falls under three general headings: (1) Basic Ecological Principles and Concepts; (2) The Habitat Approach; and (3) Applied Ecology. The subheadings within each chapter are broken down into a statement of the concept, an explanation of the statement, and, usually, examples to illustrate the point. This serves to bring the concept within the actual experience of the reader and makes it more nearly real than hypothetical. The student or non-specialist can gain a clear understanding of the subject matter and know what the author is writing about with this kind of treatment. In my estimation this is one of the main features of the book. There are many well chosen charts and other illustrations to drive the points home.

Another good feature of the book is the way the author handles the complicated terminology that has grown up around the science of Ecology. When he uses a term, he explains what he means by it. Whether you agree with his definitions or not, you at least know how to interpret the terminology in the light of what he has to say. The lack of uniformity in definition of terms has been one of the main stumbling blocks to a clear understanding of ecological principles, at least for a non-ecologist like myself.

The section on applied ecology is particularly good and should help sell the science to those practical-minded individuals who might otherwise think of Ecology as something for the professors to play around with, but as having no application to human affairs. A selected bibliography of nearly 13 pages and an adequate index to subject matter terminate the book. I cannot conclude this short review without recommending the book as being among the best on Ecology that have made their appearance in recent years, particularly for the person who wants an insight into Ecology without a superfluity of technical jargon. —WILLIAM H. BURT.

Allen, Durward L. OUR WILDLIFE LEGACY. New York, Funk and Wagnalls Company, x + 422 pp.; illus. 1954. Price, $5.00.

The field of wildlife management, being relatively new, has grown so rapidly that qualified personnel has not always been available to do the job at hand. We have been operating pretty much on a trial and error basis, and much of it has been error. As a consequence, we find ourselves faced with the reality that, as Allen states at the beginning of his book, ". . . the patient—our wildlife resource—is ill; and it is important to all of us that the patient get well."

Unfortunately, most of our wildlife resource is still managed from the Legislative chambers by what are usually well-meaning people, but people without knowledge of fundamental biological principles. They have not seen fit to turn management over to technical men who have been trained for the job.

This is understandable in part when we see men in key positions, in our state and Federal agencies, who do not have the qualifications by training or experience to fill those positions. Here, again, it is not wholly the fault of the agencies; they are victims of circumstance. There are more important positions available than there are qualified people to fill them, so individuals are moved into those positions prematurely. This situation, fortunately, is improving, but the Legislator is not yet convinced that he can turn the whole thing over to the technical man. Until that day comes, our patient—our wildlife resource—will not have improved noticeably.

It has been my contention for some time that wildlife resource management is largely the management of people. First, we must educate the masses; we must, somehow, make them conscious of the fact that the Natural Resources of this country belong to them. This is not an easy task. If Allen's book, OUR WILDLIFE LEGACY, is read by enough people, it will

go a long way toward helping the situation. He has presented many of the present day problems in a most lucid manner, and he has suggested some ways to remedy them. It is expecting too much to assume that our wildlife administrators will immediately follow his formulae, but his treatise should stimulate serious thinking among the lay public and eventually exert its influence at the administrative level.

In my estimation, OUR WILDLIFE LEGACY is the best book on the conservation and management of our Natural Resources to appear in many a year. It is easy reading; it is based on factual material; and it lets the chips fall where they may. Allen does not skirt around controversial subjects; he presents the facts as he sees them and lets the reader draw his own conclusions. This fearless treatment of touchy subject matter is most commendable. I recommend it as required reading for every citizen of these United States.—WILLIAM H. BURT.

Leopold, A. Starker and F. Fraser Darling. WILDLIFE IN ALASKA. Ronald Press Co., 15 East 26th Street, New York City. ix + 129 pp., 22 phot., 6 maps, 7 tables. Boards. Nov. 18, 1953. Price, $2.75.

By plane, in less than three days, a person can travel from a center of stateside culture and technology such as New York City to native villages in Alaska that are just emerging from Stone Age culture. The Territory, inhabited by native Eskimos and Indians, and colonized by persons of other ethnic groups and cultures, is a fifth as large as the United States. After traveling thousands of miles there, mainly by plane, in the period June 1–Sept. 27, 1952, Leopold and Darling were duly impressed by their experiences in that vast and rugged land. Their report is packed with ecological and conservation data which cannot well be abstracted here, but some of the highlights are as follows.

It is clearly evident that, since colonization by whites, the Territory has done its share of repeating conservation policies and practices (or lack of them) down to the present that are proven mistakes elsewhere. Examples: introducing exotics, over-protecting game, using the wolf as a "whipping boy" when the blame for failures lay elsewhere, and placing undue emphasis on predator control. There are many obvious instances where cooperation among enlightened individuals, especially in government agencies, can alter such matters. Most problems need to be tackled *in toto*, because (1) wildlife values are greater than other values in the Territory and are worth the effort, (2) the relation of wildlife to at least part of the human population is an almost symbiotic one, and (3) enough knowledge currently exists on which to base better policies.

Much of the report deals with caribou. There is clear evidence that destruction by fire and/or overgrazing by introduced reindeer have reduced vast amounts of winter range to a point where it and the undamaged remainder cannot carry an appreciable increment on the reduced caribou population now present. The answer to the problem is range preservation. That is basic. Except very locally, it far outweighs controlling such factors as direct predation by humans and carnivores; even part of the budget currently allotted for these activities could be spent to better advantage for some other purpose, such as research or conservation education.

The rapid increase in reindeer numbers and the crash that followed were due to mismanagement of the range. The empirical knowledge of the Lapps was not understood and applied in Alaska. The basic facts of lichen range management were not recognized until too late. In substance, lack of perception of range utilization plus poor herding practices led to the present depleted state of the herds. In 1941 Froelich Rainey (APPLIED ANTHROPOLOGY, 1: 9–14) clearly showed why, from a cultural viewpoint, nomadic native herders were nonexistent. Even had they been developed, perhaps they could not have comprehended that there is a critical point in lichen utilization; before it is reached, reindeer must be moved elsewhere in order not to ruin the range for decades. Viewpoints such as Rainey's have not received adequate attention. It is to be hoped that the present report will find its way into many hands and induce better results.

Moose are doing well—perhaps too well—in parts of the Territory. Although they are

over-hunted near Indian settlements, there are local over-populations elsewhere. The suggestion is made that antlerless moose be harvested, also that controlled burning might keep plant succession in proper stages (in limited areas) to sustain high moose populations. As elsewhere, in deer habitat where there is inadequate harvesting of the annual surplus, coupled with very limited winter range, the blacktail in southeastern Alaska is subject to the usual wasteful die-offs. The writers subscribe to Adolph Murie's findings that weather is the basic factor controlling the numbers of Dall's sheep. Muskoxen were placed on Nunivak Island, where there are no wolves. True, muskoxen have a low breeding potential, but one wonders if these individuals might have done better had there been a place available for them which had not been overgrazed and overbrowsed by reindeer.

Pertinent suggestions for needed research are scattered throughout this report. It is repeatedly implied that wildlife and wilderness recreation values are the best uses for much of the Alaskan terrain. There is urgent need of understanding of and conservation of the range; control of fire by coordinated action of the several government bureaus concerned is the paramount current need. The authors suggest that an intensive study of caribou would be costly, but well worth the price. They also suggest that the great wilderness area comprising the eastern portion of the Brooks Range and vicinity be preserved as an "arctic wilderness." Such ideas are set forth in a style that is easy to read. Researchers, administrators, and the public can study this report profitably. It is not a comprehensive coverage of all Alaskan wildlife and its problems. It is, however, a lucid exposition of solid ecological ideas and conservation practices, applied to certain problems in an area where they are badly needed.

To the New York Zoological Society and Conservation Foundation go the credit for sponsoring this ecological reconnaissance; to the authors go the credit for producing a very readable report that ought to be studied by all persons interested in Alaskan conservation problems.—Ralph S. Palmer, *New York State Museum, Albany 1, New York.*

Gray, James. How Animals Move. New York: Cambridge University Press. xii + 114 pp. 52 figs., 15 pls. Price, $3.00.

The author of this well-written little volume is a Fellow of King's College and Professor of Zoology in the University of Cambridge. The book, whose purpose is to illustrate ". . . how some of our commoner animals move and how they obey the same fundamental laws as those which govern the movements of inanimate things," is based on a series of six Christmas lectures delivered to a juvenile audience at the Royal Institution in 1951.

Chaper 1, entitled "The Machinery of Animal Movement," includes a discussion of the elementary physics of propulsion as applied both to non-living objects and animals, followed by a review of the ways in which animal movement is brought about from a simple ameboid type to the relatively more efficient and complex system of rigid levers and muscle antagonists. It concludes with the principles of levers and muscle function.

A survey of the principal modes of animal locomotion begins with a treatment of swimming in Chapter 2. Nature's use of the sail, jet, and paddle as propellers are noted, but the major portion of the chapter deals with the swimming movements of cetaceans and fishes. The use of the fins by various fishes as stabilizers, propelling devices, and supporting structures is discussed. The sense organs by which fishes control their movements or respond to disturbances in the water also receive brief mention. In Chapter 3, "Walking and Running," the author compares the problem of the evolution of the land-living animal from a fish to that of producing ". . . a car from a submarine without ever taking it to pieces completely or putting it out of commission." The problems of support and balance in a terrestrial environment are considered, and the steps leading to the development of the pentadactyl limb and its function are reviewed. The cycle of limb movements during different rates of walking, the trot, and the gallop are outlined, using the newt, toad, horse, and dog as examples. A comparison of the structure and function of the plantigrade and digitigrade foot is also made, and the factors limiting the speed of ungulates are briefly treated. The mechanics of jumping and creeping are considered in Chapter 4. The physics of jumping are discussed in some detail. The relative ability of such noted jumpers as the

flea, grasshopper, frog, and kangaroo are compared, and the leaping of the salmon is discussed. Snakes are cited as an example of formerly tetrapodous animals that have returned to the older principle of backbone and muscle propulsion. Such methods of serpentine locomotion as the sinuous glide, concertina movements, rectilinear glide, and side-winding are explained.

The last two chapters pertain to flight. Chapter 5 discusses elementary aerodynamics, volplaning and its employment by various vertebrates, the characteristics of gliding and soaring flight, and the mechanisms of thermal and "gust" flying. It concludes with mention of the way in which birds achieve stability and control in flight through the response of wings and tail to the influence of the semicircular canals. In Chapter 6, "Flapping Flight," excellent series of high speed photographs of flying pigeons enable the reader to follow the discussion of the principles and differences involved in slow, or rising, and normal sustained bird flight. Several paragraphs are devoted to the flight of bats and their use of echo-sounding. Insect flight is also treated, mention being made of the rate of wing beat in different sized insects and of the energy requirements for the intense muscular activity encountered in some forms. A discussion of the direction of the wing stroke, the lift and drag forces developed, and the techniques by which these phenomena have been studied follows. Attention is also given to the sensory devices, chiefly the halteres, that subserve the maintenance of equilibrium during flight.

Many zoologists are certain to find this summary of the principles of animal locomotion both interesting and instructive, although some will undoubtedly wish for a more detailed treatment of those groups in which they have particular interest. This can in no way be considered as a criticism of the work, since the book is written in a brief and simplified manner for persons without previous biological training. The author's style is lucid and concise. The illustrations are excellent and effective, being closely integrated with the text and contributing greatly to its clarity. A minor typographical error noted is the misspelling of *Draco volans* on page 95.—James N. Layne, *Department of Conservation, Cornell University, Ithaca, N. Y. (Current address: Department of Zoology, Southern Illinois University, Carbondale)*

RECENT LITERATURE

(Conducted by David H. Johnson, Claude W. Hibbard, Charles P. Lyman, Richard H. Manville, and Henry W. Setzer)

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DATE OF ISSUE OF PREVIOUS NUMBERS

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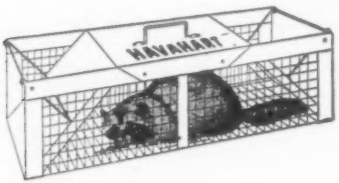

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